

# SCIENCE

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FRIDAY, AUGUST 16, 1929

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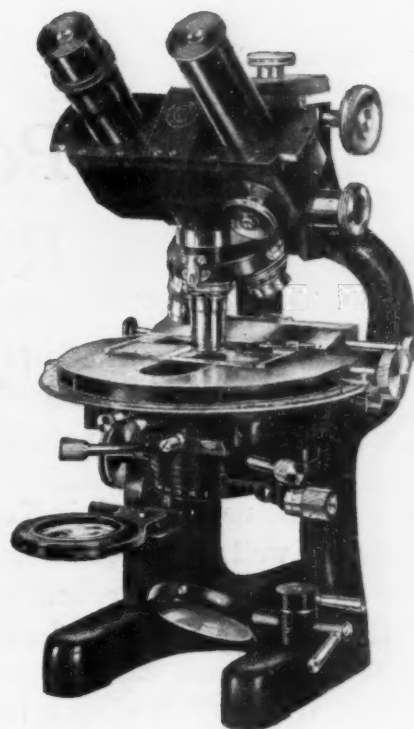
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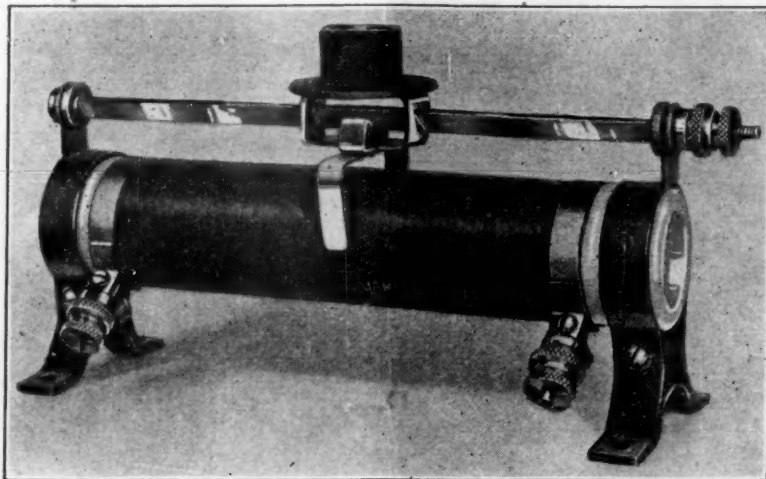


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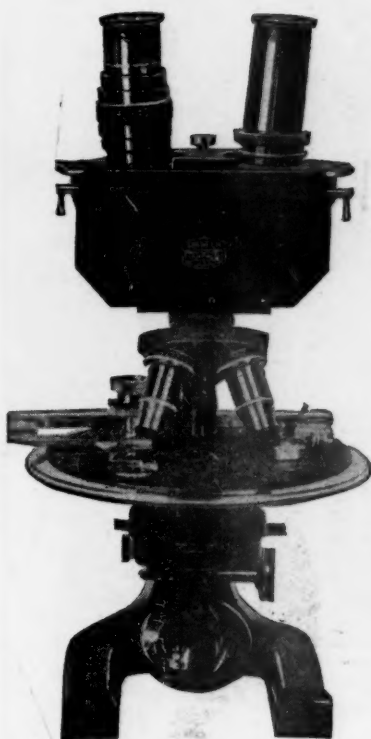
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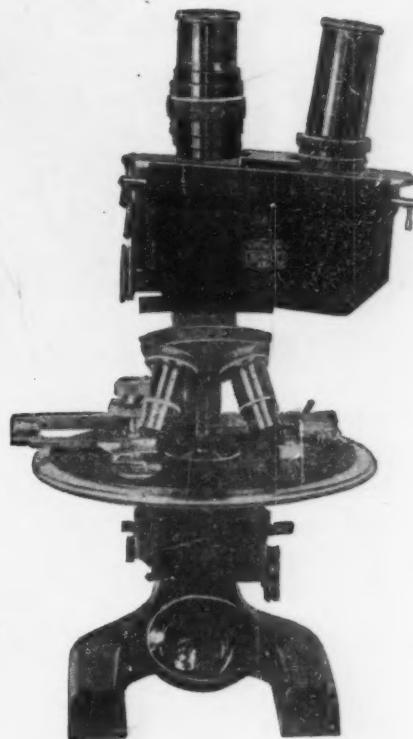
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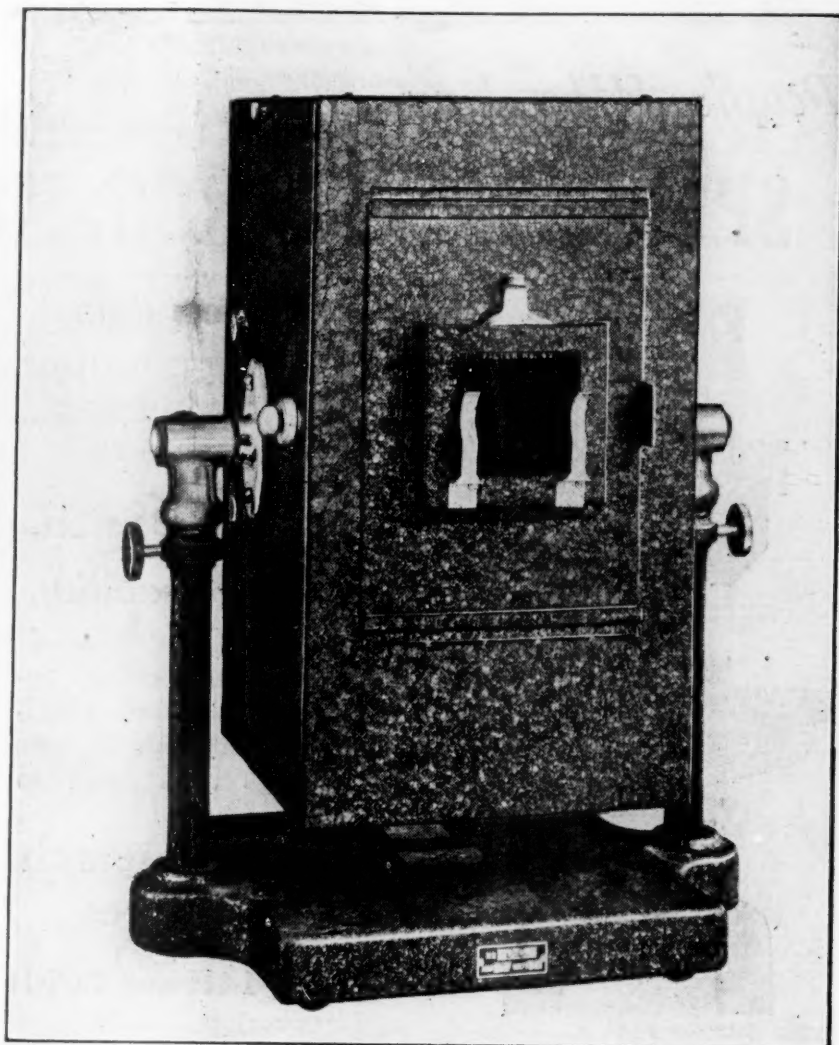
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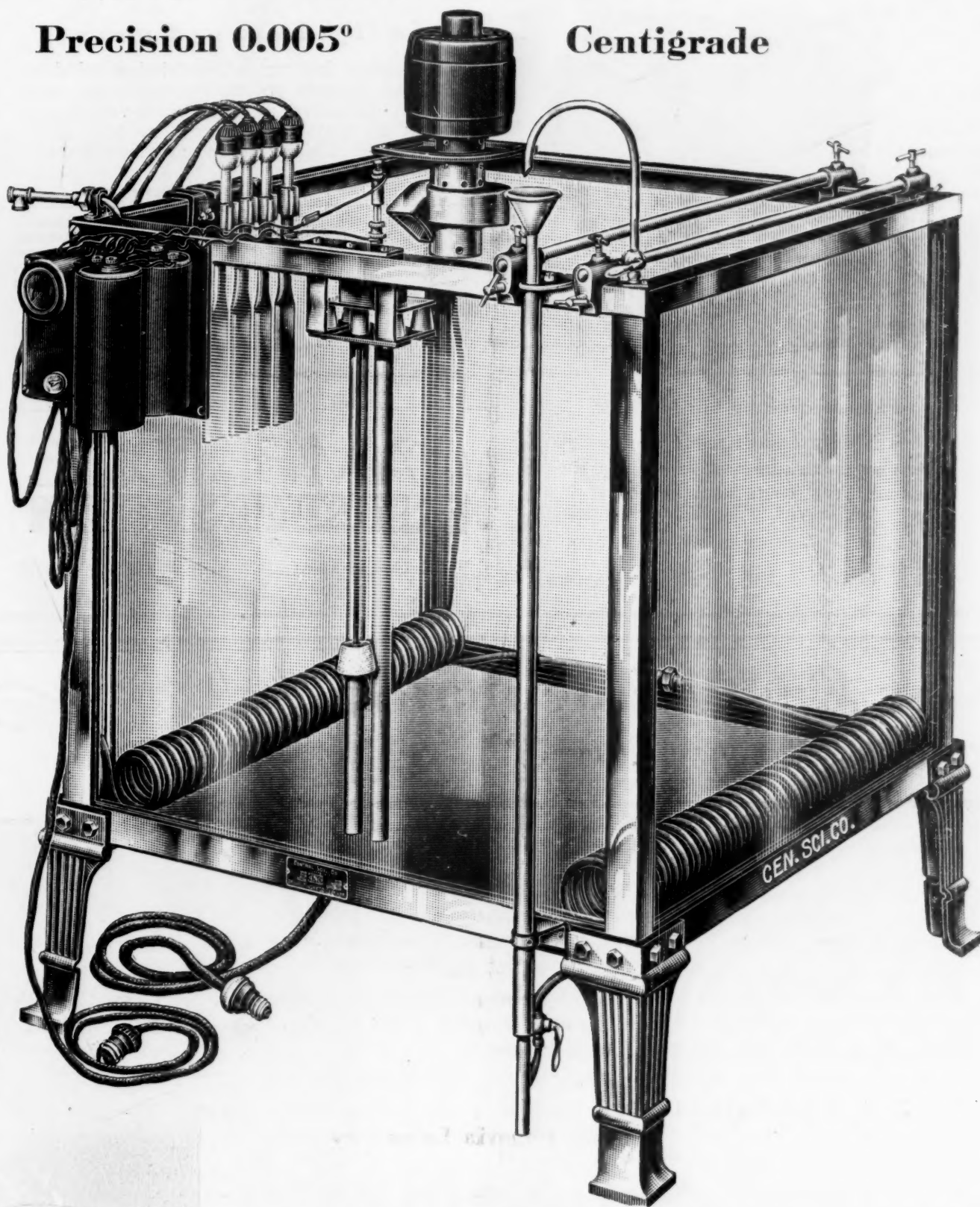
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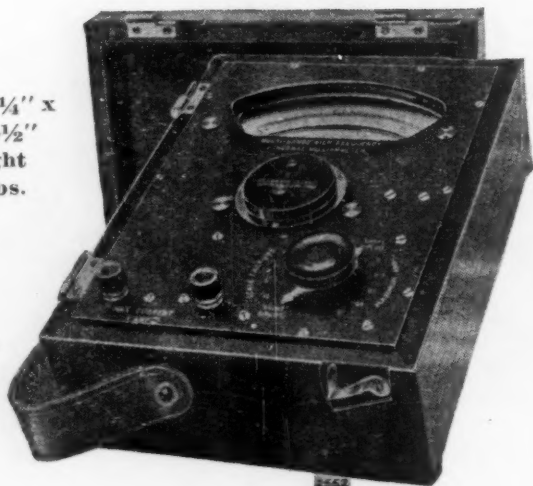
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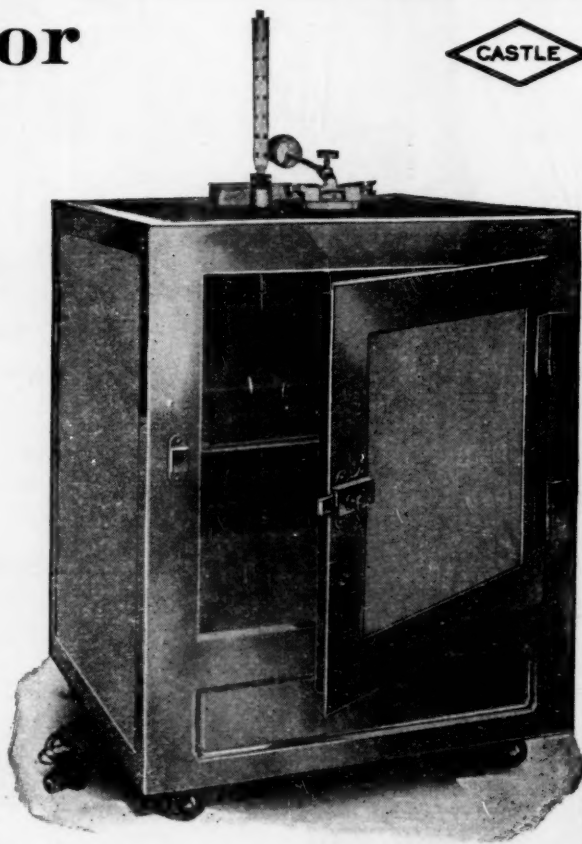
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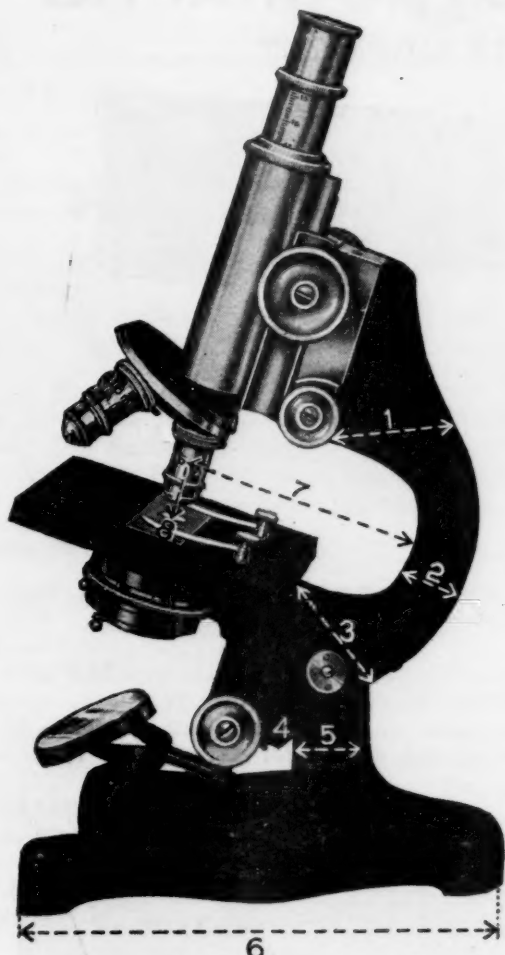
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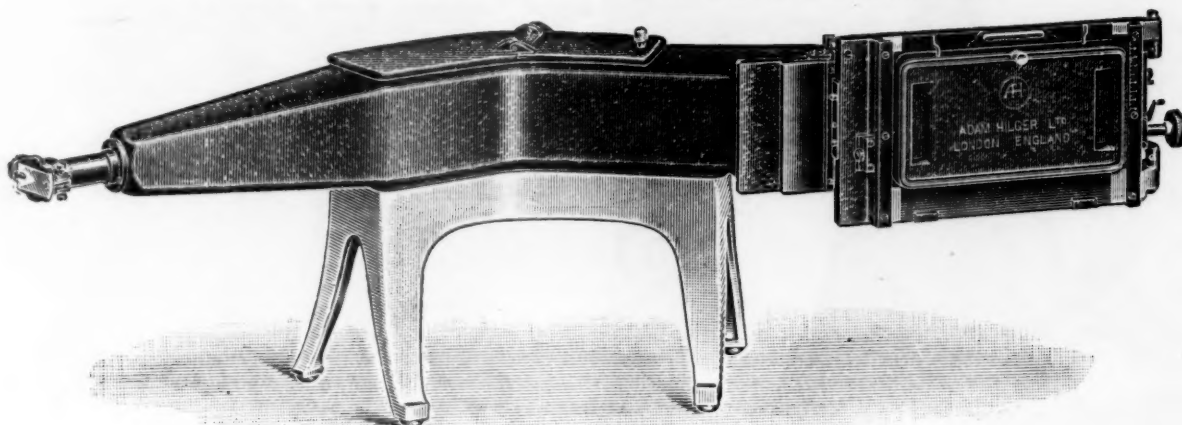
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# SCIENCE

VOL. LXX

FRIDAY, AUGUST 16, 1929

No. 1807

<i>The Chronaxic Switching in the Nervous System:</i> PROFESSOR LOUIS LAPICQUE .....	151	<i>Scientific Books:</i> <i>Bailey and Spoehr on the Rôle of Research in the Development of Forestry in North America:</i> PRO- FESSOR HENRY S. GRAVES .....	170
<i>The American Association for the Advancement of Science:</i> <i>The Second Berkeley Meeting of the Pacific Divi- sion:</i> DR. ARTHUR G. VESTAL .....	154	<i>Scientific Apparatus and Laboratory Methods:</i> <i>New Forms of Dry and Wet Bulb Thermometers:</i> PROFESSOR ALEXANDER MCADIE .....	172
<i>Scientific Events:</i> <i>The Australian Institute of Anatomy; Malaria in India; Soil Surveys Approved by the Pacific Sci- ence Congress; The Philippine Research Institute; The Bermuda Oceanographic Expedition</i> .....	159	<i>Special Articles:</i> <i>Is Ossification Influenced Solely by Ultra-violet Light?</i> PROFESSOR R. ADAMS DUTCHER and H. E. HONEYWELL. <i>A Comparison of the Copper Con- tent of Oklahoma Wheat with Those of Other States:</i> JAMES E. WEBSTER and FRANK JANSMA .....	173
<i>Scientific Notes and News</i> .....	162	<i>Science News</i> .....	x
<i>University and Educational Notes</i> .....	166		
<i>Discussion:</i> <i>Need for an International Repository for Original Research Data:</i> PRESIDENT R. W. THATCHER. <i>Preservation of Natural Areas:</i> DR. WILLARD G. VAN NAME. <i>Insect Nutrition:</i> PROFESSOR E. F. PHILLIPS. <i>New Fossils from Maine:</i> PROFESSOR EDWARD S. C. SMITH .....	167		
<i>Special Correspondence:</i> <i>The Field Trip of the Ohio-Kentucky Academies of Science and the Seventy-fifth Anniversary of the Kentucky Geological Survey:</i> PROFESSOR CHAS. H. BEHRE, JR. ....	169		

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## THE CHRONAXIC SWITCHING IN THE NERVOUS SYSTEM<sup>1</sup>

By Professor LOUIS LAPICQUE

PHYSIOLOGY has until now paid but very slight attention to the important part which time, in the sense of duration of the stimulus, plays as a condition of excitation, and has given no thought whatever to the correlations of such time characteristics among functionally related cells. I shall not here inquire into the historical reasons for such an oversight or show in detail how Du Bois Reymond, the omnipotent master of electro-physiology for half a century, was to blame for this. But I must mention the pioneers, Fick, Brücke, Engelmann, who had begun to open the way seventy years ago, but whose valuable work on the time factor in excitation has long been buried in undeserved oblivion. Engelmann went so far as to use the phrase "physiological time" to indicate the difference between quick muscles and slow ones, noting

that excitability was correlated with contractility in this respect. But he drew no further inferences from this relationship, and his remark awakened no echo.

In order to indicate the possible physiological significance of the time factor of excitation let me review some of the classical notions as to the mechanism involved in the central nervous system.

A spinal reflex is generally accepted as the elementary unit in terms of which the more complicated functions are to be explained. But, as Sherrington has emphasized, the ordinary flexion reflex of the decapitated frog, as it pulls up its leg when pinched, is by no means a simple phenomenon. Any reflex motion, as well as any voluntary motion, implies coordination. Every joint is provided with antagonistic muscles, which tend to move it in opposite directions when they contract, and if all should contract at the same moment motion would not result, but

<sup>1</sup> Introduction to the Dunham Lectures at the Harvard Medical School, 1928-29.



merely rigid posture. Such a phenomenon can be seen in true tetanus or in strychnine spasms. In the reflex which we took as an example the flexor muscles contract, the extensor muscles do not. Following a very gentle pinch the response may be so limited as to raise up only the pinched toe; a little stronger stimulation will cause a raising of the whole foot; with a still stronger one the foot flexes upon the leg, the leg upon the thigh, and even the thigh upon the hip. That is to say, when the reflex spreads it does not involve muscles at random, not even the neighboring muscles in topographical order; but instead we see something that we must call selection. In his well-known book, "The Integrative Action of the Nervous System," Sherrington says: "Increase in intensity of stimulation of the plantar skin does not, in my experience, make the spinal reflex action flow over, so to speak, from the flexor muscles to the extensors."

Is there any anatomical arrangement that could explain this matter? Investigations attempted by Sherrington for this very purpose give no explanation. He states, "The afferent fibers from each even small area of the skin of the foot do not enter together as a tiny group into the spinal cord in any single filament of a single afferent root, but scatter, and make their entrance into the cord *via* a number of rootlets, belonging not merely to one, but to two or even three adjacent afferent spinal roots . . . their collaterals and terminals must, as it were, seek out the motor cells of the above-cited flexor muscles, and . . . leave the motor cells of other muscles, for instance, of the extensors, alone."

I have quoted Sherrington's own words, not to suggest that Sherrington was satisfied with such an explanation, but in order to show, by an example textually borrowed from one of the keenest investigators neurology has ever known, how narrow was the point of view in this direction. Every explanation of nervous conduction turned on geometrical arrangements.

About the time that Sherrington's book was published, I was first proposing the introduction of a *temporal* point of view. The time factor was not yet as sharply defined as "chronaxie" now is, but nevertheless I had already recognized its importance in the function of the neuromuscular relay.

In outline the conception is this: every anatomical element, every kind of cell, reckons time according to a particular standard, say thousandths or perhaps hundredths of a second. In a given neurone, nervous impulses on the one hand, and excitability, on the other, are governed by this particular time standard. The impulse coming from one neurone to another can only stimulate the second one if the temporal

characteristics of both are equal, or nearly so. In other words, excitation will pass easily if neurones in anatomical connections are "isochron," but will not pass at all if the neurones are "heterochron." As a matter of fact, the motor impulse of a peripheral nerve will no longer activate the striated muscle it controls if either the nerve or the muscle has been poisoned so as definitely to change its natural time factor.

Now that radio has become so popular the following comparison will make clear this change of point of view. For ordinary telegraph and telephone, as well as for electric bells, the only thing which counts is connection—conducting wires, keys, switches, and so on—in short, a system of channels opening to the current a pathway materially defined. The classical conception of the nervous system is implicitly identical, referring the problems of its behavior to the presence of continuous pathways. These pathways were formerly thought to be constituted of fibers and cells, more recently of chains of neurones, or sometimes of transneuronic fibrils, but in any case physiologists wanted primarily to be able to indicate pathways on a sheet of paper.

In wireless, different waves cross each other simultaneously in the field of the receptor, but the only waves which count are the ones having a period, reciprocally a length, tuned to the time constant of the apparatus. Several sets of apparatus placed side by side and bathed by the same waves but differently tuned will function independently of each other. One may be talking while the others are silent. The chronaxic theory of nervous function has not been deduced by transposition of the principles of the wireless telephone. It is quite different, and furthermore it was formulated ten years before the invention of the radio; but for the particular case which we have considered such a transposition is sufficient to show the possibility of a non-anatomical explanation.

It is not necessary to suppose that the afferent fibers have been clever enough to get in touch with the flexor motor neurones while carefully avoiding the extensors. If the chronaxie of the flexor neurones differs sufficiently from that of the extensors, the sensory impulse, reaching both at the same time, but tuned to one of these chronaxies, will not be able to stimulate the neurones with a different chronaxie.

These differences of chronaxie really exist.

We know, from accurate measurements, that in the nerve-muscle preparation excitation fails to pass when the chronaxies of nerve and muscle differ in the ratio of 1 to 2 or more.

Bourguignon, who is a physician well acquainted with the chronaxic method, has studied for years the excitability of the voluntary muscles in man. Review-



ing his figures he recognized, without having foreseen such a result, that for every limb the chronaxies of the extensors on one side and the flexors on the other side always differ in the same ratio: 1 to 2.

Soon after an independent research gave the counter-proof. Strychnine intoxication makes flexors and extensors contract simultaneously, causing the well-known tetanus. Now Bremer and Rylant in 1924 and 1925 have observed that under the influence of this poison the chronaxies of all nerves tend to become alike and even equal.

These facts afford a solution of the question of reflex coordination as already proposed. No matter if afferent fibers touch extensor as well as flexor motor neurones; the spread of impulses may follow the temporal laws of wireless, not the geometrical laws of electrical bells.

We have not yet considered the whole problem of nervous function. We have discussed the reflex of a decapitated animal pulling back its extended limb when stimulated. But this limb, if previously flexed, will often respond to a similar stimulation by extension. In general it is well known that a spinal reflex may be reversed by modification of posture. Moreover, if we examine the behavior of a normal animal with its nervous system intact, we see that stimulation of any point on the periphery may elicit a response at any point of the body, either remote or neighboring, and initiate any kind of motion. And when we say motion, we must always think of coordination, that is, selection between antagonists, at every joint. But, as in the reversal of the reflex we considered, this selection must vary under different conditions.

If we had to deal with a railway system, we should obviously think of switching, a piece of rail being moved off or on, and the same could be said of any system of electric circuits. If we understand that in the case of the nervous system all material structures are motionless, and that the selection among the various pathways depends on the relation of the time constants of adjacent neurones, we can speak of "switching" in this case also, with a newly assigned meaning. Every neurone ramifies in order to meet several other neurones and each of these ramifies in turn, and so on. An infinite number of neurone pathways start from each point on the body and we can trace one of these paths from neurone to neurone to any effector organ. Among such numberless anatomical pathways a given scale of chronaxies facilitates conduction in certain paths and hampers or even blocks the others. If some of these chronaxies happen to change, obviously some of the open pathways will be blocked, and, conversely, some of the others will be changed from impassable to passable. The possibility of such chronaxie switching would

give at least the necessary starting-point for an explanation of nervous function. The question is whether such switching really occurs.

It is generally believed that the chronaxie of a neurone depends on its substance and structure. We must now add the idea that this constitutional chronaxie can be modified by the action of other neurones. The need of such an influence was noted in the first sketch of the theory twenty years ago, but it was verified experimentally for the first time in 1923 by Mme. Lapicque. She noticed that the motor nerve of the gastrocnemius, studied in an injured or even a decerebrate frog, shows a variable chronaxie, as a rule smaller than the value characteristic for the leg severed from the body. Severing the nerve from the spinal cord, or transection of the bulb, that is, removing the control of the encephalon, reestablished the usual chronaxie at a constant value. This proved that the mesencephalon has the power of modifying the chronaxies of peripheral motor nerves. In contradistinction to the constitutional chronaxie we will call this modified value the "subordinate chronaxie."

Thus we see how the variety of reactions in an animal with its nervous system intact can be explained. The brain is able to switch the impulse from one effector organ to another because it can functionally connect or disconnect any given neurone path by tuning its elements. Moreover, the brain itself is composed of neurones presumably subject to the same laws, that is to say, these neurones have each a constitutional chronaxie which can be modified by the action of any neurone in contact with it. In fact a series of recent researches have shown that the chronaxie of the cortical motor centers is essentially variable. This topic was first investigated by my assiduous collaborators, M. and Mme. Chauchard. They were originally led into error by the action of anesthetics, which considerably increases the cortical chronaxie in doses practically insufficient to modify the chronaxie of peripheral nerve. (By the way, I am inclined to believe that anesthesia may depend in large measure on the chronaxie disjunction so produced.) But even apart from this action we have to deal with a continually changing chronaxie. Two years ago, a young American psychologist, Rizzolo, of Columbia, worked on this question while in my laboratory. He succeeded in modifying systematically the chronaxie of the cortex by application of heat or cold or previous electrical excitation to the part of the body connected with the motor area under investigation. At nearly the same time, another of my disciples, Henry Cardot, now professor of general physiology at Lyons University, with several collaborators, found very different values for one and the

same center, changes in this case being induced particularly by activity of the vagus nerve or of the thyroid gland.

Thus we see that this power which we attribute to the brain, of switching by tuning of chronaxies, is not an anthropomorphic fancy, hidden behind a supposed mechanism. This power will appear as an obvious consequence of the nature of the mechanism itself when research along this line has been sufficiently advanced. In the meantime, the analysis of spinal reflexes, either simple or complicated, should be first worked out, for this is the best way to reach little by little a knowledge of the entire nervous system. Perhaps I may cite very recent researches, or rather the first result of a series just initiated. We have found that the chronaxie of the motor neurones of each muscle, in a decerebrate animal, undergoes large variations according to the posture of the limb. This indicates that reversal of a reflex depends on chronaxie switching.

Our theory easily solves the problem of inhibition. This phenomenon, until now so mysterious, does not raise any difficulty for the theory of chronaxie switching. Let us consider the question in terms of the

same classical example of an elementary nervous function that we chose for excitation itself. In the so-called "simple reflex" we have seen that extensors must not contract at the same time as flexors. There is something more than this. These extensors, in the state we call rest, are really in a condition of slight tension, designated long ago as "tonus." This tonus depends on a slight continued nervous activity. Sherrington, as is well known, has shown that in the flexion reflex at the very moment when their antagonists contract, the extensor muscles relax; that is to say, their tone is inhibited. We explain this in terms of our theory, by assuming that in the chain of neurones carrying the tonic impulses there is one whose chronaxie may undergo such a change as to produce disjunction. This is obviously only one particular aspect of the switching mechanism. We have pointed out that as between two or more pathways anatomically established, homochronism and heterochronism serve to open one of these pathways and close the other. Inhibition may be regarded as simply the closing of certain pathways. If alteration in the chronaxie of nervous elements explains the opening of nervous pathways it likewise explains their closing.

## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

### THE SECOND BERKELEY MEETING OF THE PACIFIC DIVISION. II

By Dr. ARTHUR G. VESTAL, Secretary

#### AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS—PACIFIC SLOPE BRANCH

(Report by R. E. Campbell, Secretary)

Three sessions were held separately and one with the termite investigations committee. Chairman O. H. Swezey opened the first session with a discussion of the evolution of certain insect species in Hawaii. E. O. Essig reported that beans taken from Indian graves in Peru of periods A. D. 1 to 500 and 1000 to 1500 showed the work of the bean weevil, and one nearly perfect specimen was obtained. Ralph H. Smith showed how various practices affected the mixing and application of oil sprays. G. P. Gray and A. F. Kirkpatrick showed that a heavy dose of HCN gas followed by a light dose is more destructive to scale insects than light followed by heavy dose. They gave added proof that in certain districts the black scale is more resistant to HCN than in other districts. F. B. Herbert discussed codling-moth control in the northwest. A paper by S. L. Allman gave details of the control of the codling-moth in Australia. A. M. Boyce told of progress in study of the walnut husk fly, a new injurious insect in southern California. W.

B. Herms announced that all stages of the Hippolates fly have now been found and the breeding-places located. E. A. McGregor reported promising results in the control of citrus thrips and citricola scale by the use of very finely divided sulphur. Perez Simmons described certain advantages of ethylene gas for fumigating dried fruit to kill insects. H. J. Quayle gave observations on the Mediterranean fruit-fly in Florida. Don C. Mote gave an account of the habits of the strawberry crown borer. The crawling of newly hatched larvae down the outside of the crown may prove to be its vulnerable point. F. H. Wymore showed that hydrated lime and gypsum applied with or without an arsenical will control cucumber beetles. There was little injury from the lime. R. L. Webster reported on serious damage to potatoes in western Washington from larvae of flea-beetles. H. R. Hagan gave a paper on the principal fig insects of Smyrna, and methods employed to meet the new requirements in figs shipped to this country. G. H. Vansell reported that the German requirement of diastase in honey is unjust, as many types of honey are naturally very low in diastase. Efforts by G. H. Vansell and



S. B. Freeborn to find the source of diastase revealed a small amount in pollen and in the mid and hind gut of the honey-bee. R. W. Doane gave an account of how ambrosia beetles plant, cultivate and harvest fungi for food.

The entomologists' dinner was held on June 20 at Stephens Union. Officers for the ensuing year are: Don C. Mote, *chairman*; Perez Simmons, *vice-chairman*, and Roy E. Campbell, *secretary-treasurer*.

#### SAN FRANCISCO AQUARIUM SOCIETY

(Report by G. S. Myers, President)

A session was held on June 19. C. E. Grunsky, in an account of "The Aquariums of Europe," compared their equipment and collections with those of American public aquariums, particularly the Steinhart Aquarium in San Francisco. He emphasized the greater attention paid to public education in the American institutions. B. W. Evermann's paper on "The Scientific and Educational Value of Public Aquariums" referred especially to their teaching and informational value. George S. Myers spoke on "The Use of Fishes in Mosquito Control," particularly of the success in the campaign against yellow fever in the American tropics. He outlined the problems involved in combating malaria.

#### THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

A group of western members of the society met at luncheon on June 20 to organize a western division. Organization was effected, and the following officers were elected: J. O. Snyder, Stanford University, *president*; R. L. Bolin, Hopkins Marine Station, *vice-president*, and G. S. Myers, Stanford University, *secretary-treasurer*. Plans for a fall meeting were discussed.

#### TERMITE INVESTIGATIONS COMMITTEE

Since the research activities of the termite committee are centered at the University of California, it was appropriate that some of the results be presented in a special program on the occasion of the gathering of the scientific societies at Berkeley. Two programs were held on Friday, June 21, the morning session with the Western Society of Naturalists, the afternoon session with several of the biological groups. Bessie Noyes described the sense-organs of *Termopsis angusticollis*. F. H. Connell presented the life-cycle of an *Oxymonas* from *Neotermes simplicornis*. Bessie J. Andrew's experiments on refaunation in *Termopsis* were reported by S. F. Light. The internal associates are lost during ecdysis, but are reacquired in several ways. N. L. Wihr explained how the intestinal protozoa of *Termopsis* differ characteristically during suc-

cessive developmental stages. Experiments by T. D. Beckwith and E. J. Jones showed the varying effectiveness in cellulose-digestion of organisms from the termite gut. A. E. Peterson described experiments in transferring faunas from one termite species to another.

In the program of the afternoon, S. F. Light gave a general account of the geographic distribution of termites. Harold Heath, who has worked for many years at Stanford University on morphology and development of termites, told of the origin of the termite castes. A. L. Pickens described the natural history of *Reticulitermes hesperus*. Merle Randall reported on the chemical basis of the protection of wood against termite attack. Harold Kirby, Jr., outlined some of the problems in the study of the protozoa of termites.

Dr. Light's address before the Pacific Division on Friday evening was also on termites, and gave an able résumé of the economic problems occasioned by them.

#### ECOLOGICAL SOCIETY OF AMERICA

(Report by A. W. Sampson, Secretary for the Pacific Coast)

A session was held on the afternoon of June 20, and a second, with the Western Society of Naturalists, the next morning. Ernest Wright presented results of experiments on tolerance of seeds of woody plants to high temperatures. Those of certain chaparral shrubs were most resistant. C. F. Shaw presented a formula summarizing factors of soil formation. These are climate and vegetation acting upon parent material through time, with results modified by deposition or erosion. E. B. Copeland reported that certain chaparral shrubs in the mountains above Chico, California, use about forty inches of water a year, as estimated by the cobalt-chloride paper method. A. W. Sampson showed that establishment of vegetation on clay horizons exposed by erosion of topsoil is retarded. Water-requirement, as found in cultures, is much higher for the B horizon. Low nitrogen content may be responsible. W. C. Lowdermilk showed that forest litter functions beyond its saturation by rain in influencing absorption of precipitation. On bare slopes, muddy water seals the pores and increases superficial run-off and erosion. H. de Forest presented data on environmental conditions in chaparral in southern California. He emphasized water relations and the reaction of the vegetation upon physical conditions. A. G. Vestal showed how chaparral bushes are killed by insufficient rainfall or by cattle, and how successional trends and dominant species vary with differences of soil texture and soil development.

R. C. Miller described the life-history of certain wood-boring mollusks of the *Teredo* group, and pre-



sented a graph of resistance of the northwest shipworm to fresh water. Results were presented of studies by T. G. Thompson, R. C. Miller, R. U. Bonnar and A. W. Snoke on physical factors and plankton-content of sea-water in Puget Sound during 1927-1928. Esther Pardee Topp and Francis Marsh Baldwin presented data on physicochemical changes in sea-water off southern California as related to occurrence of plankton. Summaries by W. E. Allen of phytoplankton collections during ten years from the Atlantic and Pacific Oceans show predominance of near-shore diatoms, with greatest abundance in the vernal period. D. H. Wenrich gave results of studies of seasonal distribution of four ciliate protozoa of ponds. The fluctuations in numbers could not be correlated with temperature. Elsworth Lumley and R. C. Miller showed that morning awakening of birds is primarily a function of illumination. Forty-five per cent. of California quail, as reported by E. C. O'Roke, are infected with *Haemoproteus lophortyx*, which has a life-cycle similar to that of the malarial parasite. The disease is transmitted by the parasitic louse-fly *Lynchia hirsuta* Ferris.

#### WESTERN SOCIETY OF NATURALISTS

(Report by C. V. Taylor, Secretary)

The Thursday morning program of invitation papers opened with E. L. Walker's report of his studies on leprosy, showing that stages of *Actinomyces leprae*, found in soil, are identical with bacteria from lepers, also with Hansen's acid-fast bacterium. F. W. Weymouth reported on comparative growth-rates of the Pacific razor clam over a range of 2,500 miles of coast-line. The slow initial growth of northern forms is associated with a later more rapid growth, larger size and longer life. For all localities the growth-rate throughout life forms a descending geometric series. O. L. Sponsler concluded from X-ray analysis that cellulose exhibits a crystalline structure whose components closely approximate the glucose molecule. O. Larsell demonstrated that size reduction of the right optic lobe of tadpole larvae, following removal of the left eye, was due to absence of functional stimulus normally reaching the cortical opticus.

In the afternoon program, A. R. Moore reported that fertilization and development of the sea-urchin egg can occur without either the fertilization or the hyaline membrane. In balanced lethal strains of *Drosophila melanogaster*, E. B. Babcock and J. L. Collins found that lethal mutations occurred 100 per cent. oftener under conditions of greater earth radiation. W. H. Manwaring concluded that protein symbiosis remains a possible factor in evolution. B. M. Allen, through transplants of hypophysis of 17 mm into 30 mm *Rana* larvae, induced in the latter decided

color changes. Florence Landry and F. M. Baldwin found that the body temperature changes in the Gila monster differ from environmental temperature never more than 3° C. C. H. Danforth showed by skin transplants that the factors controlling so-called hen-feathering are located chiefly in the skin, except that in the same race control is effected by the endocrines. K. Scott Bishop and A. F. Morgan reported mild xerophthalmia and other signs of vitamin-A deficiency in rats having abundance of vitamin A in diet, due to change in the Ca/P ratio. The construction of micro-thermocouples was described by D. M. Whitaker. They are used for temperature measurements within the living cell to one two-thousandth of a degree. J. F. Kessel and H. Jenks discussed identification of five species of *Eimeria* in the intestine and liver of rabbits, based on form of micropyle and residual body. It was shown by Laura Garnjobst that encystment and excystment of the ciliate *Holosticha*, found near the Plymouth Laboratory, can be induced at will and that its binary fission occurs only within the cyst. Louise Shedd gave an account of induced encystment of *Bursaria*, and the dedifferentiation of its ciliary apparatus.

Officers elected for the ensuing year are: *President*, O. L. Sponsler; *vice-president*, O. Larsell; *secretary-treasurer*, C. V. Taylor; *council*, B. M. Allen and A. R. Moore.

#### SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE —PACIFIC COAST BRANCH

(Report by T. D. Beckwith, Secretary)

Sessions were held Thursday afternoon and Friday morning, in the Zoology Building. Experiments by J. M. Luck and Melville Sahyun showed that epinephrine with insulin in rabbits markedly increases the glycogen content of the liver, although there is no such change of glycogen content in the skeletal muscle. M. Barmore and J. M. Luck stated that phosphates (the  $PO_4$  ion) increase the velocity of biological oxidations. B. M. Allen reported that injection of pars intermedia into tadpoles produces intense pigmentation, but implantation of pars nervosa does not produce pigmentation. Combined they produce also a contraction of the body wall. A second paper by Dr. Allen stated that thyroxine brings about metamorphosis of tadpoles, whether the thyroid or hypophysis be present or removed.

W. H. Manwaring, J. L. Azevedo and T. H. Boone showed by immunological technique that foreign protein injected into an experimental animal may multiply there. Dr. Azevedo and Dr. Manwaring showed that when a foreign serum albumen is injected into an experimental animal, the most persistent fraction of the alien protein is the globulin. Diseased ducks

studied by Paul A. Shaw showed rectal temperatures about 2° C. less than normal. There is a slight increase in blood sugar and an increase in uric acid. G. J. Peirce reported the use of a suspensoid of starch to determine ascent of water in stems. Only certain of the vessels in wood can carry water. Tests of absorption of agglutinins by B. S. Henry showed distinct differences between *Brucella melitensis* derived from pork and strains derived from bovine sources. K. F. Meyer and B. Eddie have discovered that in macacus monkeys the feeding of bovine *Brucella abortus* induces an infection without fever. Pork strains cause a febrile reaction. The monkey has a certain degree of intestinal immunity against these bacteria. P. J. Hanzlik and D. A. Wood, in an account of mechanism of digitalis emesis in pigeons, stated that the liver is the seat of action resulting in emesis, and that this is a vagus reflex. C. C. Johnson gave his finding that acidosis after administration of salicylates is moderate only.

According to M. L. Tainter and W. VanDeventer, antiedemic actions of calcium and parathyroid extract in experimental systemic and local edemas are conditioned more by blood pressure than by the calcium content. T. D. Beckwith showed that the green alga *Chlorella* has a somewhat bacteria-like metabolism. Certain strains reduce nitrate to nitrite; one variety changes nitrite to nitrate. Peptone stimulates them. Utilization of different food-substances varies with light conditions and tends toward a basic reaction. John F. Kessel transferred *Giardia lamblia* to kittens. He found that the cat may serve as a reservoir host for man. Olive Swezy and Herbert M. Evans reported that mammalian ova have a shorter life span if unfertilized than any group of cells in the body outside of the reproductive tract. Dr. Swezy and Dr. Evans in another paper suggested that maturation of human embryonic ova may possibly be due to the action of maternal hormones, which have no effect upon male embryonic cells. E. G. Martin found that energy requirements of individual muscle fibers during violent exercise are three thousand times greater than that of resting muscle. A. F. Morgan and G. L. Anderson found that a deficiency of vitamin A in the dog brings about a progressive decrease in allantoin secretion, compensated in part by increase in uric acid.

#### BOTANICAL SOCIETY OF AMERICA—PACIFIC SECTION

(Report by G. J. Peirce, Chairman)

Sessions were held in the forenoons of June 20 and 21. The first session began with the presentation by A. S. Mulay of a statistical study of total nitrogen in Bartlett pear shoots. Intensity factors in growth were discussed by H. S. Reed. Work by K. S. Mark-

ley and Charles E. Sando suggested that too much waxy material on the skins of apples may cause storage scald by retarding respiration. The relation of wind injury to gumming in orange twigs was discussed by E. T. Bartholomew. He showed in a second paper that petroleum spray oils actually penetrate into citrus tissues and are found as droplets within the cells. W. V. Cruess and W. Y. Fong described the effect of hydrogen-ion concentration on the inactivation temperature of fruit oxidases. W. B. Davis and C. G. Church reported that ethylene hastens ripening of persimmons, probably through its influence upon respiration. H. L. van de Sande Bakhuyzen gave additional experimental evidence for his colloidal theory of permeability.

A demonstration of genes was given by Dr. John Belling on Thursday afternoon. The botanists participated Thursday evening in the dinner for biologists.

The Friday morning session began with a business meeting. H. P. Barss was elected chairman for the next year, and E. T. Bartholomew, secretary-treasurer for the next two years. W. W. Mackie discussed the origin of cultivated barley in the light of genetic and pathological indications. E. E. Stanford proposed certain revisions in the classification of the *Polygonums* of western North America. W. M. Heusi presented results of experiments on taxonomic relationships of *Zauschneria*. F. Murray Scott demonstrated Golgi apparatus in the seedling of *Vicia faba*, and presented her interpretations. Effects of high-frequency radiations on plants were shown by T. H. Goodspeed. D. N. Borodin presented tables designed to indicate effects of mitogenetic rays on cells of root-tips, and showed photomicrographs of the root sections.

#### AMERICAN PHYTOPATHOLOGICAL SOCIETY—PACIFIC DIVISION

(Report by B. A. Rudolph, Secretary)

Four half-day sessions of the society were held with an average attendance of forty members.

H. S. Fawcett reported transmission of *Nematospora coryli* to citrus, pomegranate and cotton bolls by *Leptoglossus zonatus*, the western leaf-footed plant-bug. C. O. Smith regards *Phyllosticta narcissi* Ander. and *Stagosporium Curtisii* (Berk.) Sacc. as identical, since either may produce pycnidia and spores of the other when inoculated in the scapes and leaves of *Amaryllis*. E. Carsner and C. F. Lackey demonstrated that mass action in sugar-beet curly-top is a factor in infection. It is suggested that this phenomenon is a reversible chemical reaction. W. W. Mackie found no resistance in bread wheats to *Sep-toria tritici* but by repeatedly crossing them with re-



sistant varieties has produced a resistant hybrid. Mackie also crossed hybrids highly resistant to barley "scald" with highly susceptible plants. The progeny suggested a 3:1 ratio of susceptible to resistant due to a single factor for resistance. M. Shapovalov's observations indicate that psyllid yellows may be transmitted with the tubers. The progeny may show various stages of the disease. Mixed with mosaic in the same plant distinct reactions occur. Harold E. Thomas finds there is no correlation between the growth of *Armillaria mellea* on the expressed sap from the root of a host, and its resistance. C. F. Lackey showed that curly-top virus can be attenuated by passing through certain plants. Chickweed reactivates the attenuated virus to almost its original virulence. R. H. Marloth described physiological differences existing between *Penicillium italicum* and *P. digitatum* grown in culture as a means of differentiating between them. Evidence obtained by O. Swezy and H. Severin indicates that Rickettsia-like organisms found in the intestines of infective *Eutettix tenellus* from curly-top sugar-beets have a filterable stage. J. B. Kendricks found sulphur-containing compounds to be distinctly inferior to copper-lime dusts in preventing the germination of spores of *Bremia lactucae*. Kendricks also outlined promising results obtained in the selection of *Fusarium* wilt and root-knot resistant cowpea varieties. Wm. T. Horne distinguished between the better-known diseases of avocado and suggested the new name "Carapace spot" for a certain blemish attributable to mechanical injury. The histological work by L. J. Klotz upon citrus fruit decayed by *Penicillium italicum* and *P. digitatum* shows that there is no observable difference in the method of attack of the two species. A study made by L. D. Leach indicates that under California conditions *Sphaerotheca humuli* overwinters on raspberry debris rather than in the buds of this plant, as reported elsewhere. Ruth F. Allen discussed heterothallism in *Puccinia graminis*. Her paper was generally considered to be of notable excellence. Ralph E. Smith summarized all that is known of diamond canker, the comparatively new disease of prune. Evidence that it is of parasitic origin was presented. In another paper Smith reported isolating *Sclerotinia sclerotiorum* from many healthy cultivated plants, wild flowers and weeds placed in moist chambers. Ascospores blown to these plants are believed responsible. H. N. Hansen presented evidence that *Phoma terrestria* sp. nov. is responsible for pink root of onions rather than the *Fusaria* now associated with the disease. L. J. Klotz and H. S. Fawcett have studied the relative susceptibility of seventy-eight species and varieties of citrus to bark infection by *Phytophthora citrophthora*. H. Knight, J. C. Cham-

berlin and C. D. Samuels found saturated oils of 60 seconds Saybolt viscosity to affect respiratory processes of plants less than those of 75-110 viscosity. W. Jones and T. E. Rawlins reported that the electrical resistance of juice and tissue of potato tubers affected with spindle-tuber disease is lower than that of sap and tissue of healthy tubers. H. S. Fawcett and C. L. Shear have found a *Diaporthe* to be the perfect stage of *Phomopsis californica* Fawcett. A technical description will soon appear. C. P. Sideris has studied the relative susceptibility of many economic plants to attack by *Pythiaceae* root-fungi isolated from pineapples and other Hawaiian crops. In other papers he described diagnostic characters for the genera *Nematosporangium*, *Pythium*, and *Phytophthora* of the family *Pythiaceae*, and enumerated species of these genera and other fungi which attack the pineapple. J. T. Barrett reported an unusually heavy infestation of Golden Ophelia roses with aerial crown-gall, there being practically no root infection. B. A. Rudolph has prepared a digest of the literature dealing with *Verticillium hadromycosis*, also a complete host index based on the literature.

Motion-picture films of members of the society were shown during the sessions and were greatly enjoyed.

#### WESTERN PSYCHOLOGICAL ASSOCIATION

(Report by P. R. Farnsworth, Secretary)

The opening session, on Thursday morning, June 20, was devoted to a wide variety of topics. H. E. Weaver discussed his work on the tachistoscopic and eye-movement aspects of the reading of music. H. E. Jones described the instruments now being used in the child work of the Institute of Child Welfare at Berkeley. J. G. Yoshioka reported that the albino rat shows no sense of direction in an ordinary maze situation, but in an open space it orients itself directly toward the goal. E. A. McNulty displayed test item results on children of identical mental age but of very different chronological age. P. R. Farnsworth reported success in considerably raising the reliability of two "music" tests, Victor Record 35773, and no success with Columbia Record A 7539. A paper by H. H. Jasper on "Relationships between Perseveration, Introversion and Depression" concluded the session.

J. E. Coover began the Thursday afternoon session with a paper demonstrating that the learning curve of certain functions is not qualitatively homogeneous throughout. H. R. DeSilva discussed data which indicate that binocular summation of brightness exists, contrary to orthodox opinion. That there is more individuality in the heart-rate response when subjects are at rest than when at work was indicated by the work of W. R. Miles. R. H. Seashore cited advan-



tages for the project method of conducting advanced laboratory classes in psychology. The thesis that albino rats can learn a maze with the aid of visual cues alone was supported by A. Walton. The last paper was by G. M. Stratton, on the behavior of different nationalities in the United States.

C. C. Miles opened the Friday morning session with a presentation of data on sex differences in certain emotional attitudes. H. C. Gilhousen reported a study of errors in learning to work a serial choice reaction-time apparatus. J. Ball discussed a method of quantitative measurement of sexual excitability in the female albino rat. A paper by H. R. Taylor on the prediction of college success at the University of Oregon closed the session.

Three papers were offered during the last session. Herman Adler described the founding and operation of the Institute for Juvenile Research at Chicago. R. Redfield followed with a discussion of the meaning of mind to a social anthropologist. The last paper was by R. C. Tryon on genetics of learning ability in rats. After the annual banquet in the evening, retiring President Warner Brown spoke on the nature of intelligence.

#### WESTERN SOCIETY OF SOIL SCIENCE

The soil scientists' meetings were on the two days preceding the general meeting. The morning session of June 17 included two papers on peat soils of the west coast, and three dealing with alkaline soils and pH. Soil-moisture and soil-temperature problems were the principal subjects considered during the afternoon session. A symposium on base exchange in soils occupied the morning of June 18. The afternoon and evening sessions were chiefly devoted to problems of plant nutrition.

The new president of the Pacific Division of the American Association is Dr. Douglas Houghton Campbell, emeritus professor of botany, Stanford University. The new secretary, to fill the unexpired term of Dr. Vestal, is Dr. James Murray Luck, assistant professor of chemistry at Stanford University. The change become effective on August 1.

The 1930 meeting of the Pacific Division and associated societies will be held at the University of Oregon at Eugene; the 1931 meeting probably in southern California.

## SCIENTIFIC EVENTS

### THE AUSTRALIAN INSTITUTE OF ANATOMY

THE correspondent of the *Journal* of the American Medical Association writes that the commonwealth of Australia is the custodian, for the world, of an almost unique fauna. Particularly is Australia unique in regard to the marsupials, some of which, such as the kangaroo, the wallaby and the koala, are found nowhere else. It is fitting, therefore, that the comparative anatomist should seize the opportunity of studying these mammalian curiosities, for there is no doubt that the marsupial, like the Australian aboriginal, is disappearing. Both are difficult of domestication. Already the Tasmanian aboriginal has vanished, leaving behind a few skeletons. Since the position regarding the marsupials was realized, about twenty years ago, efforts have been made to study and preserve the species. Large tracts of suitable virgin country, such as Wilson's Promontory in Victoria, have been set aside as sanctuaries for native fauna. Although not receiving the recognition and encouragement it deserves, enthusiastic anatomists, chief among whom is Dr. Colin Mackenzie, have done valuable work by an extensive study of the mammals and reptiles of Australia.

Since the foundation of the national capital at Canberra, plans have been prepared for the Australian Institute of Anatomy, the erection of which is estimated to cost £100,000. The buildings will cover an

area of 44,450 square feet and will be erected on a site of 8 acres. Dr. Colin Mackenzie has been appointed director of the institute. This appointment has been universally approved. Associated with the institute will be a reservation of 80 acres occupying a peninsula of the Molongolo River, where members of the unique Australian fauna will be studied in their natural state.

Canberra is destined to become the anatomic center of the Pacific, and from the point of view of specimens the Australian Institute of Anatomy will, in the future, rank second only to the Hunterian Museum of the Royal College of Surgeons in London. Dr. Colin Mackenzie has donated his complete anatomic museum, consisting of hundreds of macroscopic specimens and thousands of microscopic preparations. Other notable gifts include the Horne-Bowle collection of aboriginal stone implements, the Murray Black collections and valuable specimens from Messrs. Otway Falkiner and E. Hill. Mr. Harry Burrell, of Sydney, has presented to the institute his unrivaled collection of specimens dealing with the life history of the platypus. The present value of the collections is estimated at £100,000, and, at the present rate of accessions, in a few years, they may be worth £250,000.

Facilities for study will be offered not only to research workers in this country but to those from overseas. The institute will afford exceptional oppor-

tunities for studying human embryology from the functional point of view. Already, considerable work of great practical value has been done with regard to uterine support, to the anatomic relationships of the ureter and genital ducts and to the comparative anatomy of the mandible, the central nervous system, the colon, the greater omentum, the lesser sac and the vermiform appendix. The marsupials offer an excellent field for the study of the muscular epochs, and the postural changes resulting.

#### MALARIA IN INDIA

STATEMENTS concerning malarial conditions in India are contained in the annual report for 1928 of the Ross Institute and Hospital for Tropical Diseases. According to the *London Times* it recalls that Sir Malcolm Watson and Major Lockwood Stevens went to India on an expedition of inquiry last November and sailed for home last April. They made an extensive tour and drew up reports which will be published later. In the meantime the Ross Institute in the present report gives a summary of their observations as follows:

Bombay was first inspected. Compared with many other places the control of malaria in Bombay Island, indeed its complete elimination, is a relatively simple task. The mosquito which carries the disease lives chiefly in tanks, wells and cisterns. A certain number of these have been closed or covered; and there is an able staff under Dr. Sandilands, the health officer of Bombay, capable of completely stamping out the disease. But there still remain a large number of breeding places, and eighteen years after the source of the danger was pointed out by Dr. C. A. Bentley, the director of public health of Bengal, the people of Bombay, and especially the mill workers, suffer severely from the disease.

Malaria is steadily spreading through many parts of Bengal. Within living memory hundreds of villages have been decimated; thousands of acres of once prosperous and highly cultivated land have been abandoned; populous towns have been reduced to the status of miserable fever-stricken villages; stately mansions have as their sole inhabitants the wild pig and the leopard; and the jungle is creeping in to reign once more over a land from which it was driven thousands of years ago. The malaria of Bengal may well be described as a great tragedy.

There is much controversy on the cause of the malaria in Western Bengal. Many hold, among them Dr. Bentley, that malaria has been increased by the embankments which have interfered with the natural flooding of the Delta. They claim that, where the land is flooded annually by the rivers of the Delta, there is a surprising immunity from malaria, and that malaria is specially intense where railways, canals, roads and embankments have killed the rivers or reduced their flow. The other view is that the malaria is due to insufficient drainage of the land. Its supporters claim that what drainage has done

to banish malaria from other lands it can do for Bengal. Sir Malcolm Watson considers that there is a strong case for an independent inquiry, and he has written to the governor suggesting that this should be made.

#### SOIL SURVEYS APPROVED BY THE PACIFIC SCIENCE CONGRESS

PRESENTATION of the soil survey work of the U. S. Department of Agriculture by Dr. Oswald Schreiner, chief of the division of soil fertility, of the Bureau of Chemistry and Soils, and official representative of the department at the Fourth Pacific Science Congress, held this summer in Batavia and Bandoeng, Java, was followed by a resolution of the congress urging all Pacific countries to extend soil survey work as far as possible on a uniform basis somewhat comparable to the methods by which the United States has already mapped and surveyed half of its agricultural land.

According to reports from Java, received this week by Dr. Henry G. Knight, chief of the Bureau of Chemistry and Soils, Dr. Schreiner was appointed chairman of a standing committee on soils charged with the task of working out a uniform basis of classification for the soils of Pacific countries in co-operation with the International Society of Soil Science.

Following the meeting of the Fourth Pacific Science Congress at which he was chosen chairman of the soil section, Dr. Schreiner attended the Third Congress of the International Sugar-cane Technologists held at Sorabaya, Java, where he was again elected chairman of the soils section.

In addition to their appointment of a standing committee to further the work of soil survey in Pacific countries, members of congress showed much interest in the latest work of the U. S. Department of Agriculture in soil erosion prevention and in the recent findings of the Bureau of Chemistry and Soils as to the successful application of the rarer and little-known fertilizing elements to certain soil types, upon which subject Dr. Schreiner presented papers.

"No mere words can describe the absolute 'otherness' of the civilization one sees on this island. It is so different that it mystifies. It is beautiful, enchanting and altogether delightful," wrote Dr. Schreiner in a recent letter to Dr. Knight. He tells of towns and villages with strange and beautiful temples everywhere, richly carved with grotesque figures of gods and demons.

"Java has been called the jewel of the tropics," he writes, "but Bali with its tropical setting and interesting people is the real gem of these far-eastern islands; enchanting, intriguing, surpassingly beautiful, the most tropical, the most eastern of them all. The bronze statues of beautiful men and women, superb



in form and bearing, amid old and crumbling temple walls, with a background of palms and other tropical plants and wonderfully terraced rice fields, make this island a paradise for artists and all who love the beautiful."

Dr. Schreiner has supervision of extensive field tests with fertilizers in various soils of this country and is making a special study of agricultural conditions and fertilizing practices in the growing of tropical crops such as tea, coffee, rubber and sugarcane, with a view to applying his information to the soils of the southern United States.

#### THE PHILIPPINE RESEARCH INSTITUTE

SYSTEMATIC scientific research in the Far East is planned by the organization of the Philippine Research Institute. L. O. Colbert, director of coast surveys of the Philippine Islands, has been elected director and treasurer of the institute. The director of the Coast and Geodetic Survey, R. S. Patton, in a statement made to the *U. S. Daily*, said that the new organization is not connected with the Philippine government but will have the cooperation of the insular administration.

"The institute's stated purposes," Captain Patton said, "are four-fold. First, it is designed to provide a center for pure research in the natural sciences in the Far East. Second, it is to carry on scientific investigations and experiments in the fields of biology, chemistry, physics, mathematics and other natural sciences. This will be with a view to aiding applied science in the alleviation of disease and in assisting in economic and industrial development of the Philippines, through research in pure science. Third, it is proposed, through advances in pure science, to stimulate interest along more practical lines in economic and industrial development in the Far East. Fourth, it is proposed through this organization to advance the training of Filipino scientists in experimental methods and to create more wide-spread interest in the fundamental scientific problems of the Philippine Islands.

"The institute has been promised the assistance of the government in the use of certain facilities.

"It is understood that funds will become available shortly from expected donations. These are to be used for the establishment of fellowships for pure scientific research along lines to be laid down by the directors of the new organization.

"The institute will seek money primarily for the encouragement of research in pure science. It will, however, handle funds for the encouragement of any investigation which might be desired by the donors of funds.

"With the establishment of a definite institution for the encouragement of scientific research and for the handling of funds for this purpose, it is hoped that more systematic and greater efforts along research lines may be developed. It is hoped, moreover, that the Filipinos may be given more incentive along research lines than is at present possible with the limited funds available for government institutions."

#### THE BERMUDA OCEANOGRAPHIC EXPEDITION

THIS expedition is the twelfth of the department of tropical research of the New York Zoological Society, and has been in the field for four months. It will remain until November 1. The director is Dr. William Beebe and the headquarters are on Nonsuch Island, Bermuda. The objects are two-fold: to make as thorough as possible a résumé of the shore fishes of Bermuda with notes on their life histories, and to study the deep-sea life of a definite, few cubic miles of open ocean. Success in both these fields has been so pronounced that it has been decided to continue the work through another year.

A sea-going tug, the smaller winch of the *Arcturus* and two and a half miles of quarter-inch cable are used in the deep-sea work. In this oceanographic phase of the expedition, three hundred and fifty net hauls have been made up to July 31. These have been confined to an eight-mile radius, five miles south of Nonsuch, and from the surface to fourteen hundred fathoms. This has yielded an astonishing harvest of abyssmal life. About two hundred species of true deep-sea and pelagic fish have been taken, representing 13 orders and 52 families.

Although separated by only five to eight miles of water, the trenchant differences between Bermuda shore fish and those from the ocean depths are far beyond expectation. One phase of this may be illustrated by the relative number of genera in six orders:

	Deep-sea genera	Shore-fish genera
Isospondyli .....	30	6
Iniomi .....	11	2
Pediculati .....	16	2
Pereomorphi .....	5	62
Jugulares .....	2	10
Plectognathi .....	2	12

Checked records have been made with a newly designed pressure gauge down to 1,600 pounds to the square inch, and living specimens have been taken in

baited traps and on radium hooks at considerable depths. Next to the actual collecting, photographing and painting of living and recently dead deep-sea fish, important work is being done in the laboratory in clearing and staining such rare forms as *Opisthoproctus*, *Lasiognathus* and *Derichthys*.

Success has been had in the use of ice for keeping abyssmal fish alive. It has proved much more effective than pressure. Dr. and Mrs. C. J. Fish spent a month at the station studying plankton and larval fish, and Professor E. Newton Harvey worked on the luminescence of living fish and shrimps for several

weeks. Among other visitors have been Dr. Henry Fairfield Osborn and Professor E. L. Mark.

Other phases of interest have been the tropic birds, fifty-five occupied nests being located on the island, and the young and old birds banded for reference next year. One effect of the absence of enemies on land birds is the reduced number of eggs deposited by catbirds, bluebirds, cardinals and English sparrows.

The scientific staff at present consists of William Beebe, John Tee-Van, G. Hollister and W. Merriam, besides R. Whitelaw, photographer, and Helen Tee-Van, L. Miller and E. Bostelmann, artists.

## SCIENTIFIC NOTES AND NEWS

PROFESSOR HARVEY CUSHING, Moseley professor of surgery at Harvard University and surgeon-in-chief of the Peter Bent Brigham Hospital, and M. Cantacuzène, director of the Pasteur Institute of Bucharest, have been elected foreign members of the Paris Academy of Medicine.

THE Royal Medico-Psychological Association at its annual meeting on July 10 and 11 elected as honorary members Professor Ivan Pavlov, of Leningrad; Sir Charles Sherrington, of Oxford, and Professor Eugenio Tanzi, of Florence.

WE learn from *Nature* that Professor Pierre Termier, directeur des Services de la Carte Géologique de France, Paris, has been elected a foreign member of the Geological Society, London, in addition to the election of three Americans already recorded in SCIENCE. Foreign correspondents have been elected as follows: Professor Othenio Abel, of Vienna; Dr. Clarence N. Fenner, of Washington, D. C.; Professor Olaf Holtedahl, of Oslo, Norway; Dr. Rudolf Staub, of Berne, Switzerland; Dr. V. K. Ting, of Peking, China, and Professor Carl Wiman, of Upsala, Sweden.

THE honorary degree of doctor of agriculture was conferred upon Assistant Secretary R. W. Dunlap by Rhode Island State College during the commencement exercises. Mr. Dunlap delivered an address, his subject being "The United States Department of Agriculture and the Land-Grant Colleges."

THE doctorate of science has been conferred by Tufts College on Dr. William Rice, dean of the dental school.

THE following appointments recently made by the Secretary of State for the British Colonies in the Colonial Agricultural Services are reported in *Nature*: Mr. W. H. Edwards, lecturer in entomology and zoology at the College of Agriculture and acting botanist

and mycologist, Mauritius, to be entomologist, Jamaica; Mr. S. M. Gilbert, superintendent of agriculture, Nigeria, to be assistant director of agriculture, Trinidad; Mr. A. Pitcairn, district agricultural officer, Tanganyika, to be assistant director of agriculture, Cypress; Mr. J. R. Mackie, superintendent of agriculture, Nigeria, to be deputy assistant director of agriculture, Nigeria; Dr. R. H. Le Pelley, to be assistant entomologist, Kenya; Lieutenant J. Eaden, to be assistant manager, Experimental Fruit Farm, Sierra Leone; Mr. H. E. Green, to be inspector of plants and produce, Agricultural Department, Gold Coast, and Mr. E. Lawrence, to be district agricultural officer, Nyasaland.

THE *Journal* of the Washington Academy of Sciences announces the following appointments in the U. S. Geological Survey: Roland W. Brown, paleobotanist to succeed F. H. Knowlton, deceased. Armand J. Eardley, David A. Andrews, William G. Pierce, Alonzo W. Quinn, Thomas A. Hendricks, Harold E. Thomas and Frank S. Parker, junior geologists in the section of geology of fuels; Marland P. Billings, assistant geologist in the same section. Howard A. Powers, junior geologist in the section of volcanology. Eugene Callaghan and Ian Campbell, junior geologists in the section of metalliferous deposits, and Quentin D. Singewald, assistant geologist in the same section.

DR. S. L. MADORSKY, Du Pont fellow in the University of Chicago, has been appointed associate chemist at the fixed nitrogen research laboratory of the bureau of chemistry and soils of the U. S. Department of Agriculture.

LAWRENCE T. CLARK has been appointed head of the laboratories of Parke, Davis and Co., succeeding E. M. Houghton, who retired on May 1 after serving for thirty-four years. Walter E. King has been appointed assistant director of the laboratories and of



the biological farm of the company, with which he has been connected since 1905.

JOHN C. FISHER, a member of the staff of the U. S. Weather Bureau at Cornell University for the past ten years, has been appointed to succeed the late Morgan R. Sanford as director of the Syracuse Weather Bureau.

ERNEST CLARE BOWER, assistant professor of astronomy and mathematics at the Ohio Wesleyan University, has been appointed Martin Kellogg fellow in the Lick Observatory of the University of California with academic residence at the Berkeley astronomical department.

*Nature* reports that the joint committee of the Royal Society and the University of Sheffield has appointed Dr. W. H. George to the Sorby Research Fellowship, tenable at the University of Sheffield. Dr. George will continue his work, begun at the Davy-Faraday research laboratory of the Royal Institution, on x-rays and crystal structure.

DR. THOMAS W. TURNER, head of the department of biology of Hampton Institute, has been granted sabbatic leave for the year 1929-1930. He plans to spend the year in study and research in Europe, and will sail for France in September.

DR. WILLIAM H. MEYER, director of the department of roentgenology of the New York Postgraduate Medical School and Hospital, sailed recently for Europe. He will study European practice in the use of roentgenology as a diagnostic and therapeutic procedure.

W. M. SINGLETON, director of dairying in New Zealand, will make an extended trip through dairy sections in the United States and Canada.

Dr. W. D. FUNKHOUSER, head of the department of zoology and dean of the graduate school at the University of Kentucky, is conducting archeological work in Logan County where he will excavate Indian mounds. Professor W. S. Webb, of the department of physics, will join him at the conclusion of the summer school.

CHARLES BROWN, director of the State Historical Museum of Wisconsin, is in North Dakota visiting points of historical and archeological interest. He will confer with North Dakota officials on plans for developing the historical museum of that state.

DR. LESLIE SPIER, director of the State Museum at the University of Washington and professor of anthropology, has left for Honolulu on a research tour to the Gilbert and Ellice Island groups in the Pacific. Dr. Spier, who plans to spend a year in research, will make an anthropological study of the

languages, customs, religion, household arts and social life of the aborigines of these islands. Little is known of the civilization and customs of the Gilbert and Ellice Islands, which are situated just north of the Fijis. Collections of oceanic life and material will be brought back to the university museum although Dr. Spier's leave of absence is to be spent primarily in the interests of the Bishop Museum in Honolulu.

DR. H. H. HOWARD, representative of the Rockefeller Foundation for the West Indies and Central America, has returned to New York after several months passed in Jamaica making research into the malarial condition in the islands. He has been in Trinidad, Grenada and Colombo to see what progress had been made in the campaign against malaria. A recent survey was started in Grenada and will continue for three or four months.

DONALD CARTER, assistant curator in the mammal division of the American Museum of Natural History, arrived in New York on August 7, after spending nine months in Abyssinia. It is reported that 300 specimens of mammals, 120 birds, a number of species of insects and some reptiles were collected. The most important part of the collection is eleven specimens of nyala (the antelope family) which was the primary purpose of his trip. The nyala is to be found only in the Aruci country in Abyssinia.

DR. STANHOPE BAYNE-JONES, professor of bacteriology in the University of Rochester School of Medicine, gave a public lecture at the University of Chicago on August 8 on "Motion Pictures in the Study of Microbiology."

DR. OSCAR RIDDLE, of the Carnegie Institution, Cold Spring Harbor, gave two lectures at the University of Minnesota on July 22 and 23 on "Control of Heredity through Control of Conditions" and "Some Interrelations of Reproduction, Sexuality and Internal Secretion."

A MEMORIAL tablet to commemorate the work of Victor von Lang, the physicist, was recently unveiled at the University of Vienna.

WE learn from *Nature* that on July 19 Sir Thomas Middleton unveiled at Dishley Grange, in Leicestershire, a memorial to Robert Bakewell (1725-95), the pioneer of stockbreeding. The movement to commemorate the great English farmer was started by Professor Scott Watson, of the University of Oxford, who had raised money in both Canada and America for the purpose. In his address Sir Thomas Middleton gave an account of the work of Bakewell and after unveiling the memorial placed a laurel wreath on his tombstone, which lies in the ruins of the old church.

It is reported in the foreign press that at the suggestion of Dr. R. J. Renison, rector of Christ Church, Vancouver, the Royal Empire Society is having a plaque made in England to be placed in Vancouver Cathedral to commemorate the work of Captain Cook in that part of the world. Records show that it was in 1778 Cook sailed up the west coast of North America. He struck the coast at Lat.  $44^{\circ} 55' N.$  on March 7, and he "proceeded to make an almost continuous survey of the coast" up to and beyond Bering Straits as far as Lat.  $70^{\circ} 41' N.$ , where he was barred by the ice. He named the farthest visible point, Icy Cape; he also discovered and named Nootka Sound, Prince William's Sound, and Cape Prince of Wales; and he penetrated Cook's Inlet. His work is believed to have inspired that of Vancouver in 1792, when the latter circumnavigated the island that now bears his name. The memorial is to be unveiled in September during the visit of Sir John Sandeman Allen, Chairman of the Royal Empire Society.

A MEMORIAL tablet to Sir Humphry Davy, the eminent British chemist, was unveiled in the Pump Room of the Wirer Endowment, at Ischl, on July 22, in the presence of Dr. Streeruwitz, the Austrian chancellor, and a party of distinguished guests, including the secretary of the British Legation in Vienna. Sir Humphry Davy spent several weeks at the Austrian watering place in the twenties of the last century. The chancellor, in a short speech, dwelt on the gratitude the world owes to the inventor of the Davy safety lamp, by which the lives of innumerable miners of all nations have been saved.

THE civil list pensions granted this year in Great Britain, amounting in all to £1,200, include annual allowances of £75 to Mrs. Agnes Maude Carey, in recognition of the inventions of her husband, the late Mr. Robert Falkland Carey, in connection with the discharge of aeroplanes from ships; £50 to Mrs. Jane Jackson, in recognition of the conspicuous service rendered to botanical science by her husband, the late Dr. Benjamin Daydon Jackson; £75 to Mrs. Elizabeth Robinson Rennie, in recognition of the services rendered by her late husband, Dr. John Rennie, by the practical application of his scientific knowledge; £75 to Miss Elinor Wallich, in recognition of the eminent services to botanical and zoological science rendered by her grandfather, the late Dr. Nathaniel Wallich, and late father, Surgeon-Major George C. Wallich, respectively; £50 to Mrs. Agnes Mary Weiss, in recognition of the pioneer services rendered to the science of aviation by her husband, the late Mr. Joseph Vincent Weiss, and £50 to Mrs. Elizabeth Mottram Williams, in recognition

of the services of her husband, the late Dr. George Chisholm Waldemar Williams, F.R.C.S., in connection with the application of Röntgen rays to the treatment of disease.

APPLICATIONS for associate and assistant metallurgist must be on file with the Civil Service Commission at Washington, D. C., not later than August 28. The entrance salary is \$3,200 a year for the associate grade and \$2,600 a year for the assistant grade. Higher-salaried positions are filled through promotion.

IN further commemoration of the twenty-fifth anniversary of the inauguration of research activities by Carnegie Institution of Washington exercises will be held on deck of the ship *Carnegie* in San Francisco Harbor on August 26, 2:30 P. M. The following program will be given. Presiding: William B. Storey, member of the board of trustees, Carnegie Institution of Washington. Brief addresses by: Dr. Henry S. Pritchett, vice-president, board of trustees, Carnegie Institution of Washington, "The Institution's Program as Originating with Mr. Carnegie"; Dr. W. W. Campbell, president of the University of California, "The Contribution of Research"; Captain J. P. Ault, commander *Carnegie*, "On the Work of the *Carnegie*"; Dr. Walter S. Adams, director of the Mount Wilson Observatory of Carnegie Institution of Washington, "Program of the Institution in Physical Sciences with Special Reference to Astronomy," and Dr. John C. Merriam, president of the Carnegie Institution of Washington, "The Work of Pacific Coast Departments in Relation to the Larger Program of the Institution."

At the Mount Desert Island Biological Laboratory the following public lectures were given during the summer. Dr. Clarence Cook Little, Jackson Memorial Laboratory, "The Relation of Genetics to Cancer Research"; Dr. Warren H. Lewis, the Carnegie Institution, "The Development of the Human Body," with moving pictures; Dr. Roy W. Miner, American Museum of Natural History, "The Accident of Size"; Dr. Charles J. Fish, Buffalo Museum of Science, "Ocean Exploration," and Dr. William Morton Wheeler, Harvard University, "What is the Cohesive in Insect and Human Societies?"

THE Eugenics Research Association, Cold Spring Harbor, is offering a prize of \$3,500 for the best essay upon the causes of the decline in the birth rate during the last forty years with especial reference to Europeans and persons of European stock. The treatment should be historical, should include an analysis of studies already made upon the subject and should lay stress upon the phenomenon in peo-



ples of Nordic, or chiefly Nordic, origin in all parts of the world. Preference will be given to essays which are based upon objective studies rather than on expressions of opinion. Essays should be mailed to the Eugenics Research Association so as to reach Cold Spring Harbor, N. Y., not later than June 1, 1930. They may be written in the English, German or French languages.

ARTICLES of incorporation were filed on June 29, at San Francisco, for the merger of the League for the Conservation of Public Health, the Better Health Service and the Hospital Betterment Bureau into one organization to be known as the Better Health Foundation. Their object in merging is said to be to bring together the forces which represent important health activities in California in the medical, sociological, sanitary and physical sciences. Dr. Reginald K. Smith is president of the new foundation; Drs. Langley Porter, dean and professor of medicine, University of California Medical School, and James W. Ward are vice-presidents; Dr. Walter B. Coffey is chairman of the executive committee, and Dr. John Gallwey is treasurer. The offices are in the Medico-Dental Building on Post Street.

THE fourteenth annual meeting of the Optical Society of America will be held at Cornell University, Ithaca, N. Y., on October 24, 25 and 26. In addition to the usual program of papers contributed by members on their own initiative, the meeting will include the following special features: (1) A commemoration of the centenary of the death of Thomas Young (May 28, 1829), at which the following papers will be presented: "Thomas Young, the Man and the Physician," by Professor H. B. Williams, Columbia University; "Thomas Young and Physiological Optics," by Dr. Selig Hecht, Columbia University; "Thomas Young and the Wave Theory of Light," by Professor Henry Crew, Northwestern University; "Present Theories of Light" (evening lecture), by Dr. W. F. G. Swann, of the Bartol Research Foundation. (2) A symposium presenting a critical analysis of the observational data bearing on the theory of relativity. Papers critically analyzing observational data will be presented covering the three major predictions of the theory, namely, The Red Shift, The Perihelion Motion of Mercury and The Deflection of Light Passing the Sun. The complete program for this symposium is not yet ready for announcement. (3) Presentation of the Frederic Ives Medal for 1929 to Professor Edward L. Nichols, honorary member of the society and professor emeritus of physics at Cornell University, at a dinner to be given in his honor. Professor F. K. Richtmyer is chairman of the program committee and Professor H. E. Howe is chairman of the local committee. Correspondence should be addressed to Dr.

L. B. Tuckerman, secretary, The Optical Society of America, Bureau of Standards, Washington, D. C.

THE Stockholm correspondent of the *London Times* reports that two hundred and fifty delegates, representing thirty-three countries, arrived at that city on July 22 for the opening of the International Congress of the Experimental Forestry Union, which was held at the Royal Swedish Forestry Academy in Stockholm. This was the first meeting of the union since 1910, and the most important it has held so far. The Prime Minister, M. Arvid Lindman, was honorary president. Proposals were made for the strengthening of international cooperation in forestry. The president of the congress, Professor Henrik Hesselman, pointed out that the science of forestry was truly international, and served the whole of humanity. The congress should therefore agree on standardized measurements and terminology. M. Flury (Switzerland) proposed the organization of an international bibliography of forestry, and Señor Valasquez (Spain) proposed the establishment of a central bureau to assist international cooperation. M. Guinier (France) presented a plan for an international organization to deliver forest seeds of guaranteed quality and origin, in order to avoid the failures hitherto frequent owing to the use of inferior seeds.

EIGHTEEN states and the U. S. Department of Agriculture were represented at the seventeenth annual meeting of the American Association of Agricultural College Editors, held at the University of New Hampshire, from July 9 to 12. Several of the colleges sent two or three representatives each. The official *Record* reports that in the exhibits competition, which was a strong one, New Hampshire and Ohio tied for sweepstakes, the ribbon being finally awarded to New Hampshire, at the suggestion of the Ohio delegation, New Hampshire having won more first prizes than Ohio. Use of newspaper and magazine space and of radio broadcasting for educational purposes in the extension of agricultural and home economics information were prominent themes of discussion at the meeting. The college editor's relations with the county extension agent had been made the subject of a questionnaire study during the year by a committee appointed at the preceding association meeting, and a report prepared by W. H. Darrow, Texas extension editor, was presented by Glenn H. Rule, editor of the University of Maine. About forty per cent. of the county extension agents now furnish extension information to their local newspapers regularly, only a very few altogether neglecting to do so, but there is a distinct need for editorial training of agents, said the report. Among the means proposed for giving agents such training were journalism courses for prospective agents while in

college, state news-writing contests for county extension agents, news-writing training meetings held by the college editor for county agents, correspondence courses in news writing and bulletins on news writing. Detailed tabulation of replies to the questionnaire of the committee was mimeographed for use of members attending the Durham meeting.

THE American Medical Association has appointed a committee to look into the danger of poisoning from methyl chloride used in some makes of domestic refrigerators. The committee includes Dr. H. Gideon Wells, professor of pathology in the University of Chicago; Dr. R. L. Thompson, of the U. S. Public Health Service; Dr. Carey P. McCord, associate professor of preventive medicine in the University of Cincinnati College of Medicine; Yandell Henderson, Ph.D., professor of physiology in Yale University School of Medicine, and Paul N. Leech, Ph.D., director of the chemical laboratory, American Medical Association.

SECRETARY OF COMMERCE LAMONT has initiated a conference to be held in Washington in the near future of the U. S. Bureau of Mines, the Bureau of

Standards and the Public Health Service to consider safeguards against poisonous gases used in mechanical refrigerators. This conference probably will be followed by a general meeting to which representatives of the mechanical refrigerative industry will be invited. The Bureau of Mines has made a survey of the danger of certain refrigerator mediums which the Public Health Service made public, on July 18. The conclusion was reached in this way that methyl bromide and methyl chloride at least and possibly ethyl bromide and ethyl chloride do not possess sufficient warning properties to prevent serious accidents and that chemical warning agents should be added to these compounds.

WORK for protecting the animal world and vegetation peculiar to Denmark, or certain parts of Denmark, and of preserving places of natural beauty is being continued with much energy. Kattehalet, a characteristic boggy area of 50 acres in North Zealand, situated between two forests, has now been acquired for a botanical and zoological nature park and sanctuary. Extension of another large sanctuary has recently been made by the owner of the Strodam estate, also in North Zealand.

## UNIVERSITY AND EDUCATIONAL NOTES

THE late Worcester Reed Warner, a mechanical engineer, member of the firm of Warner and Swasey, manufacturers of astronomical instruments, bequeathed \$100,000 to Western Reserve University and an additional \$100,000 to the Cleveland School of Arts, to which he had formerly contributed \$100,000; \$50,000 is left to the Syrian Protestant College, at Beirut, \$25,000 to Doshisha College, Kyoto, Japan, and \$25,000 is left to the American Society of Mechanical Engineers, "in perpetual trust to be invested and the income to be used to establish and provide an annual award of a gold medal to be bestowed on the author of the paper adjudged the worthiest to receive such recognition; said paper to deal with progressive ideas in mechanical engineering or efficiency in management, and the medal to be known as 'The Worcester Reed Warner Medal.'"

BY the will of the Marquise Charlotte Elizabeth de Sera of Paris, who died on July 19, Columbia University will receive \$200,000 and the Fifth Avenue Hospital \$100,000.

WILLIAM RANDOLPH HEARST has given to Oglethorpe University 400 acres of woodland adjoining the present campus in the outskirts of Atlanta. The land originally laid out as a real estate development

will be reserved for expansion of the campus. This is Mr. Hearst's third gift to Oglethorpe.

DR. ERNST GELLHORN, of Halle, has accepted a call to the University of Oregon, as associate professor of physiology in the department of animal biology.

DR. C. R. ORTON, for the past five years in charge of research for the agricultural department of The Bayer Company, Inc., and since July, 1928, in charge of research for the Bayer-Semesan Company, Inc., at the Boyce Thompson Institute for Plant Research, has been appointed professor and head of the department of plant pathology in West Virginia University and plant pathologist for the West Virginia Agricultural Experiment Station.

DR. ALFRED H. POVAH, of Northwestern University, has been appointed assistant professor of botany in the University of Cincinnati.

DR. J. H. ORTON, for many years chief naturalist at Plymouth Marine Biological Laboratory, has been appointed Derby professor of zoology in the University of Liverpool.

DR. WALTHER GERLACH, professor of experimental physics at Tübingen, has been called to the University of Munich.



## DISCUSSION

## NEED FOR AN INTERNATIONAL REPOSITORY FOR ORIGINAL RESEARCH DATA

PROBABLY the best conception of an ideally complete project of research is that it requires (1) the accumulation of a sufficient number of experimental observations to eliminate the influence of experimental error or chance variations; (2) the deduction of a hypothesis concerning the principle or law which embodies the conclusions derivable from the experimental observations, and (3) the testing of the accuracy of this hypothesis by experimental applications of it in practice until it becomes generally accepted as an addition to knowledge or guide to action. The third step in this process usually must be taken by others than the original investigator. The latter workers need to be familiar with the original data in order to plan intelligently their own experiments or to interpret confirmatory, or criticize conflicting, evidence which they may secure.

On the other hand, many investigators are content to limit their own efforts to the first of the steps of the process and to present their data for the consideration of others, leaving to some other or possibly later student the task of assembling all available data for the purpose of study of underlying causes or principles and of developing hypotheses and applications.

Either of these concepts of contribution to knowledge requires that the original research data shall be made available for the use of others. Formerly, this was fairly easily and satisfactorily accomplished by the publication of a "scientific contribution" which included in detail all the author's contributions to the problem in question.

In recent years, however, the volume of scientific research has increased so enormously that the problem of complete publication of its details has become extremely difficult. Scientific journals have multiplied in number with great rapidity and yet are unable to keep up with the demand for space. The "literature" of any single scientific problem is now so extensive as to be a tremendous burden to libraries and an almost insurmountable obstacle to comprehensive knowledge of even a narrow branch of science by any single individual.

There are two separate difficulties in the way of complete publication of original research data under present conditions. One of these is the enormous expense involved both in cost of printing and in subscription to and storage and cataloguing of scientific journals by reference libraries or individual scientists. The other is the fact that the great majority of the readers of any journal or article, under present conditions, have neither the time nor the inclination to examine the details of the individual observations

or data which an author has accumulated and are much better served by a statement from him of the number of observations recorded; their maximum, minimum and average, with a mathematical statement, if possible, of the standard deviation, probable error and odds of significance of the observed data and his conclusions and comments upon the applications thereof.

But for the sake of the occasional student who wishes to examine critically the original data of an investigation or to compare these with other similar data accumulated by himself or others, these data ought to be available. At present, efforts are made to insure this through publication of data in full in scientific journals, etc., but with the serious difficulties of expense of publication and of library space and expense, and the inconvenience to uninterested readers which have been mentioned. These difficulties are becoming so great that many scientific journals are being compelled to refuse to publish lengthy papers giving full details of experimental studies. "Abstracts" only are becoming undesirably frequent publications. Many research institutions and individuals are finding it necessary to keep in their own files or vaults the original data and to publish only summarized conclusions therefrom. The risk of safe preservation of this material for any considerable length of time in such ways as are available in local institutions and the inaccessibility of the data for later use by others make this a very undesirable form of preservation of research data. Furthermore, photostat copies or some other form of mechanical duplication of original records are a more accurate and oftentimes more usable record of such data than are the printed pages of a bound volume of a journal. Their convenience is illustrated by the demand for "separates" of printed articles.

These considerations point clearly to the need for some general system of national or international repositories for such original scientific data, where they can be safely preserved and at the same time be made accessible either for study in place or for the mechanical production of copies to be sent elsewhere for critical study by the relatively few future users of such material.

It would seem that provision for such a service might be a proper function of the League of Nations, if its activities are to be directed toward the advancement of international good-will and understanding. Or it might be very properly provided by some of the international research organizations which are already in existence or in process of formation, if they can be endowed adequately to provide the necessary facilities

and expense of operation of this repository function.

A proposal is before the Congress of the United States which has for its purpose the establishment of a national "Hall of Records," where data and records accumulated by the several branches of the federal government can be safely preserved and made available for reference. If provided, this service could probably be extended by legal enactment to include many research activities which are now supported co-operatively by federal and state appropriations, and might possibly be made available to other research data. If this were done, the problem would be met to a considerable extent so far as American scientific research is concerned, but not for that of other nations.

This need has been considered by the division of biology and agriculture of the National Research Council and by it referred to the executive board of the council with the request that attention be given to possible means for meeting the need. It is to be hoped that careful consideration of the problem and some positive action looking toward its solution may be forthcoming in the not far distant future.

R. W. THATCHER,

MASSACHUSETTS AGRICULTURAL COLLEGE

#### PRESERVATION OF NATURAL AREAS

THE article on this subject by Mr. L. G. Rommel in *SCIENCE* for July 28, 1929, makes it seem timely to call attention to the following resolution passed last winter by the Ecological Society of America at its New York meeting:

WHEREAS, Owing to their situation in high if not actually mountainous regions the National Parks fail to include any areas exemplifying some of the most remarkable, beautiful and scientifically interesting types of forest characteristic of western North America; and

WHEREAS, No fine examples of the immense Sitka spruces, lowland white firs, cedars and others of the sixteen or more species of trees that in the forests of the northwest attain a height of 200 feet or more are being permanently protected, and no satisfactory sample tract even of the Douglas fir, the most important timber tree of that region of the continent, seems likely to escape the lumbermen; Therefore be it

*Resolved*, That the Ecological Society of America ought to invite the attention of the United States Forest Service to the importance, from a scientific point of view, of setting aside, for permanent preservation in their natural condition, the finest possible sample tracts of the various types of forest in the National Forests before the rapidly progressing utilization of the timber shall have rendered it impossible to save any but inferior examples. And be it further

*Resolved*, That copies of this resolution be sent to the Secretary of Agriculture and to the Chief of the United States Forest Service.

The Forest Service has recently announced the establishment of a number of reservations for the preservation of natural conditions, but unfortunately none of these fulfil the need that these resolutions point out. They are not forested, or contain only forest growth of inferior character, and as the cutting of such timber as they bear, grazing, not only of cattle but sheep, mining, irrigation and water-power developments, hunting and fishing, and camping by vacationists are not to be excluded, their value for scientific purposes as examples of areas in their natural condition may be questioned.

WILLARD G. VAN NAME

NEW YORK

#### INSECT NUTRITION

ON December 31, 1928, the *Transactions* of the Entomological Society of London appeared, containing a valuable paper by Mr. B. P. Uvarov, of the Imperial Bureau of Entomology, entitled, "Insect Nutrition and Metabolism." This paper was prepared at the request of the British Committee on Civil Research, through its subcommittee on dietetics. The author calls attention to the fact that most papers dealing with the nutrition of insects emphasize the morphology of the parts concerned but usually give scant attention to the actual physiological processes. For this reason, special attention is given in this paper to chemistry and physiology and not to morphology. The data are, however, presented from the standpoint of an entomologist. There is an excellent bibliography of over six hundred titles.

It is not the purpose of this note to attempt a summary of a summary, but it seems pertinent to call the attention of American entomologists to this important compilation. The author and the organizations responsible for this work are to be complimented on the work, which will be most useful to their colleagues on this side.

In the introduction, prepared by the secretary of the Committee on Civil Research, it is stated that copies of the original abstracts prepared by Mr. Uvarov have been deposited in two libraries in Great Britain, for the use of those interested. Through the generosity of the Committee on Civil Research, a set of these abstracts has now been received and deposited in the library of Cornell University, where they are available for consultation. Copies of these abstracts will shortly be available for distribution through the usual library exchange, and those interested should make application through a university or public library.

E. F. PHILLIPS

CORNELL UNIVERSITY

#### NEW FOSSILS FROM MAINE

EARLY in June of this year the writer made brief visits to the slate quarries at Brownville and Monson,



Piscataquis County, Maine. The Monson slates are being actively worked, but operations in Brownville have practically ceased.

Some time was spent in working over the dumps of a number of the openings at Brownville with the hope of finding fossils. A number of ill-defined impressions resembling graptolites were collected, the best of which were forwarded to Dr. Rudolf Ruedemann, of the New York State museum, who very kindly examined them. Dr. Ruedemann is of the opinion that the remains are unquestionably those of graptolites, but their poorly preserved condition has precluded

a definite conclusion as to their genera or species. They may have been of the *Monograptus* form. So far as is known no other fossils have been reported from this slate belt.

Professor Edward H. Perkins, of Colby College, has described *Monograptus* from the Waterville area and also from Seboomook Township, northwest of Moosehead Lake, both of Silurian age; it is therefore suggested that the Monson-Brownville slate belt is also Silurian. Investigations in this region will be continued during the present field season.

UNION COLLEGE

EDWARD S. C. SMITH

## SPECIAL CORRESPONDENCE

### THE FIELD TRIP OF THE OHIO-KENTUCKY ACADEMIES OF SCIENCE AND THE SEVENTY-FIFTH ANNIVERSARY OF THE KENTUCKY GEO- LOGICAL SURVEY

ON May 30 and 31 and June 1 the geologists of the Kentucky and Ohio Academies of Science held a joint field trip in the State of Kentucky. Transportation was by automobile. On the first day the Ordovician section at Agawam Station, Clark County, was studied under the guidance of Professor A. C. McFarlan, of the University of Kentucky, and Professor W. H. Shideler, of Miami University, the party spending the night in Lexington. On May 31, the geologists, led by Professor A. C. McFarlan and Professor August F. Foerste, of Dayton, Ohio, studied the High Bridge series at High Bridge; the sequence and faulting at Parksville in Boyle County; a barite prospect in one of the subsidiary faults of the Kentucky River at Burdett (Barrett) Knob, near Danville; and the sequence and structure at this locality. The night of the thirty-first was spent in Frankfort. On June 1 the party, led by Professors W. H. Bucher, of the University of Cincinnati, and August F. Foerste, visited the crypto-volcanic structure at Jephtha Knob in Shelby County, returning thence for lunch to the home of Dr. and Mrs. W. R. Jillson in Frankfort. Here the meeting adjourned.

On the night of Friday, May 31, the two academies and their guests united with the staff of the state survey in celebrating the seventy-fifth year of activity of the Kentucky Geological Survey. A dinner was held at the New Capitol Hotel, Frankfort, at which the visiting geologists were entertained as guests of the survey. After a word of welcome from the director of the Kentucky Geological Survey, Dr. W. R. Jillson, addresses were made as follows: "Geology on the North of Kentucky," by Dr. W. N. Logan, state geologist of Indiana; "Geology on the South of Kentucky," by Dr. W. F. Pond, state geologist of

Tennessee; "Mineral Resources and Industry," by Dr. W. J. McCaughey, of Ohio State University, speaking in place of the state geologist of Ohio; "Old Days of the Kentucky Survey," by Dr. August F. Foerste, of the Steele High School, Dayton, Ohio; "Geology in Public Service," by Dr. Nevin M. Fenneman, of the University of Cincinnati; "Kentucky's Mineral Quickstep," by the Hon. F. D. Sampson, governor of Kentucky, and "Reminiscences of Seventy-five Years," by Dr. A. M. Peter, Kentucky state chemist and secretary of the Kentucky Academy of Science. Congratulations were extended to the state geologist and to the survey in the presentation of flowers by the visiting geologists; a silver pitcher and goblets were given the state geologist by the active and retired members of his staff, the presentation being made by Mr. Lucien Beckner, of Louisville, Kentucky. Later the party visited the offices of the state survey to see its map, mineral and publication exhibits.

Present on the trip were representatives of the United States, Indiana, Kentucky, Ohio and Tennessee Geological Surveys, of the Kentucky Agricultural Experiment Station, of the Ohio Bureau of Soils, of three mineral-producing companies and of thirteen universities, colleges and schools, to wit: Antioch College, Denison University, University of Cincinnati, Indiana State University, University of Kentucky, Kenyon College, Miami University, University of Michigan, Ohio State University, Ohio Wesleyan University, Steele High School of Dayton, Ohio, Vanderbilt University and Western Reserve University.

Special credit for the success of the trip is due to the energy and skill of Doctors A. C. McFarlan, A. F. Foerste, W. H. Bucher, W. H. Shideler and Mr. Lucien Beckner, as well as to the hospitality of the director of the Kentucky Geological Survey.

CHAS. H. BEHRE, JR.,  
Vice-president, Section of Geology,  
Ohio Academy of Science

## SCIENTIFIC BOOKS

*The Rôle of Research in the Development of Forestry in North America.* BY I. W. BAILEY and H. A. SPOEHR. The Macmillan Company, 1929. 118 pp.

THIS volume presents the results of a study of the problems of research in forestry conducted under the auspices of the National Academy of Sciences and supported by a grant from the General Education Board. The inquiry was directed especially to the status and needs of research in the sciences underlying forestry and more particularly those aspects of forestry comprised under the general head of forest production. The problems of forest utilization and the economics of forestry were considered only in their bearing on the central feature of forest production.

The investigation sponsored by the National Academy of Sciences was designed to determine the need for research of a more basic character than that now being carried on and to discover the principles that should underlie such a program of fundamental research as might prove necessary. The academy wisely delegated the responsibility of the inquiry to two scientists of note who were able to bring to the study a wide knowledge and experience in the experimental sciences. Messrs. Bailey and Spoehr have shown in their report an extraordinary grasp of the problems and methods of forestry, and of the peculiar conditions, economic and otherwise, which affect the extension of applied silviculture. The inquiry and the admirable report are of capital importance at this juncture. Forestry is rapidly passing out of the stage of mere protection from fire. In portions of the country silviculture is already being applied on a large number of forest tracts. The efforts so far made are chiefly based on empirical knowledge. American foresters are already faced by countless questions that can be answered only through research. To meet this situation the federal government is expending large sums for investigations in forestry, and there is, in the aggregate, considerable research conducted by the states, by universities and by the forest industries. It is of great value to have a critical study made of this work to determine its adequacy and to clarify many problems that have tended toward confusion among the foresters. The great importance of the report of Messrs. Bailey and Spoehr lies in the clear definition of forestry from the scientific standpoint, the interpretation of the character of the research that is required and the constructive proposals for the development of the investigative work needed to place forestry on a sound and enduring foundation.

At the outset the authors emphasize the distinctive character of forestry, in research and in the application of silviculture. Two peculiar characteristics of the forest must constantly be kept in mind in con-

sidering the problems of research: first, its extreme complexity as a biological unit, and, second, the long period of time required for trees to come to maturity.

The forest is very complex in its constitution, in its life processes and in its reactions under disturbing influences. A forest is not merely an aggregation of trees, representing often a considerable variety of species; it comprises also many shrubs and herbaceous plants, insects, fungi, herbivorous animals and a soil fauna and flora of great complexity, all having an influence on the life processes of the trees and of the forest as a whole. If a forest remains undisturbed for a long period of time there is established a relatively stable equilibrium. Such changes as occur, through the death of occasional trees or otherwise, do not materially affect its general character and form. This equilibrium is quickly upset by such disturbing factors as fire, windfall, insect infestations, lumbering and the grazing of live-stock. The changes that take place when a natural forest is disturbed are many and varied. The consequences of abuse are always serious. The forest may be entirely destroyed and the land laid waste by destructive cutting and fire, or unintelligent exploitation may result in a progressive deterioration of the forest, from the standpoint of its utility and economic service. On the other hand, skilful treatment may maintain and improve the productive capacity of a forest, and this fact is utilized in applied silviculture. In any case, the processes of nature are slow. The correction of abuse is a long and often an expensive process.

These facts are of importance in understanding the very nature of forestry. Ordinarily it is not possible to employ cultural methods, comparable to those in agriculture, to bring a forest into good productive condition. Forests are largely reproduced by natural means, growth is enhanced by improvement thinnings, abuses and mistakes in management are corrected by a gradual process of natural growth aided by skilful cuttings and auxiliary planting. These and other circumstances have been described with extraordinary clarity by Messrs. Bailey and Spoehr, in outlining the character of forestry and of the research problems.

Every forester will welcome the distinction drawn by the authors between the different types of research in forestry. As expressed by the authors, ". . . there are two distinct methods of investigating complex biological phenomena, one the extensive observational method of the descriptive sciences and the other the intensive analytical method of the basic experimental sciences." The descriptive sciences as applied to forestry are systematic botany, entomology, mycology, morphology, ecology, meteorology, physiography, etc., and the basic experimental sciences,



physics, chemistry, genetics and the physicochemical aspects of plant physiology and soil science. The authors state that at the present stage of forestry "in all probability the basic sciences can contribute most effectively to the extension of silviculture by helping to systematize and accelerate the process of accumulating essential data and by aiding in their analysis and interpretation, rather than by attempting prematurely to originate fundamentally scientific, silviculture techniques." The aim of research in the basic sciences should be directed, then, to a "concerted attack which aims to advance the general status of knowledge concerning forest phenomena."

Most of the research in forestry so far carried on has been of the descriptive and empirical type. The authors give recognition to the importance and character of the work that has been done by the public agencies and educational institutions. In the pioneer stages of silviculture it has been necessary to resort to the extensive observational methods of the descriptive sciences, coupled with simple experimentation, to secure quickly the basis for the practical application of forestry. "Forestry can not now wait for ultimate explanations of the extremely intricate biological phenomena of silviculture which eventually must be supplied through exact and time-consuming research in the basic experimental sciences." Nevertheless, with the intensification of silviculture, the pressure of knowledge that can be derived only from research in the basic sciences will increase rapidly, and it is important to initiate as soon as possible a program of research that reaches deeper than that which is now under way.

The authors devote a chapter to an illuminating contrast between the problems of research in forestry and those in agriculture and medicine. The difficulties in forest research center around the complexities of the physiological phenomena in the forest, the time element in experimentation with arborescent plants and the problems of controlling the environmental factors. On account of their size and longevity, trees must be studied *in situ*; they can not be grown to maturity in the laboratory as are many agricultural plants. The authors conclude that a "special physiological technique must be elaborated for their investigation."

The book contains chapters describing the progress of the movement of forestry and the work in research that has been undertaken by different agencies. In referring to the forest schools, attention is called to the lack of adequate facilities for training men for research. Most of the schools are organized primarily for the education of general practitioners in forestry. Only a few of them are sufficiently well financed to allow the staff to conduct research. This

means that only a few forest schools have the personnel and the facilities to direct graduate work. Still, again, a large part of the research work carried on by the schools is observational and descriptive in character. The stronger schools are able to offer facilities for graduate work of a character to equip men for much of the work of the federal forest experiment stations, but are less well qualified to train men for the more basic work in the exact sciences underlying forestry.

The importance of developing facilities for training research workers in the fundamental forest sciences can not be overestimated. The success of research in forestry will depend on the ability of the educational institutions to recruit men who possess natural aptitudes for research and to provide an adequate training for their development. It may be said in this connection that one reason why more men of promise have not prepared themselves for investigative work is that the occupation of forest research is not yet sufficiently stabilized to attract them. One way to meet this situation is to provide more fellowships to enable students of special ability to devote the time necessary to prepare them for research.

The book contains a discriminating discussion of the agencies now engaged in research in forestry. It is the opinion of the authors that these agencies can not be counted on to conduct the basic experimental research deemed to be essential. This is particularly true of research underlying forest production. The federal and state agencies are handicapped in fundamental research by the sheer pressure to acquire information urgently needed in applied forestry. Even a casual survey of the unsolved problems faced by the American forester indicates the extent of the information of a descriptive character that is immediately needed. It is inevitable that public appropriations for research will be made chiefly for investigations and experiments of the descriptive and empirical type rather than for work in the basic sciences.

The authors point out that the very character of the problem of basic research in forestry requires the close working together of groups of specialists in the various sciences, in physics, chemistry, genetics and the physicochemical phases of plant and soil science. This is particularly difficult to secure in the federal and state agencies. For somewhat different reasons, the common attack on a group of fundamental problems is difficult in the universities as they are now constituted. Departmental inertia, individualistic tendencies of faculty members, obligations in teaching and committee work, personnel weaknesses in some of the departments, in addition to lack of financial support, are among the reasons that militate

against the contemplated cooperation in research in the universities. Botanical gardens and arboreta are also deemed better suited to investigative work of the descriptive character than to research in the basic sciences.

The authors emphasize that the foregoing conclusions apply particularly to the problems underlying forest production. The situation is somewhat different in the field of forest utilization, where the problems are more closely analogous to those of the engineering industries. Existing agencies are already conducting researches of basic character in the properties of cellulose, lignin and oleoresins, in wood preservation and in the physical qualities of wood.

The final chapter of the book deals with the need of creating a new agency to develop the research required as a foundation of silviculture. The authors make clear at the beginning that they do not propose a great institution for the centralization of basic forest research. It is the purpose rather to provide a special administrative agency, analogous to the Kaiser Wilhelm Gesellschaft of Berlin, which would be authorized to receive and administer funds for research and would build up centers of scientific work at universities which are deemed to be qualified to carry forward carefully planned projects of a basic character. The plan would not divorce forest research from the universities and other competent agencies, nor would the outstanding scientific workers be drawn off from their university associations. As expressed by the authors:

These activities [of the central institute] should not involve the creation of a large, isolated research institute, but rather the development ultimately of several smaller research units which should be located in university centers and affiliated informally with existing scientific departments. Research thrives best and is most productive in compact semiindependent units of moderate size where the investigators are closely and informally associated, but where they are able to maintain contacts with general scientific and intellectual interests.

The first task of the new agency would be to study the status of the different basic sciences in relation to forestry. In this study the view-points of the different sciences would be brought into correlation and, in its subsequent activities, the central agency would render an important service in coordinating individual efforts in solving basic forestry problems.

The authors do not endeavor to suggest the specific lines of endeavor of the central agency. They emphasize, however, the study of the life processes of trees and forests, as fundamental to the successful practice of silviculture. "A new science of forest physiology, involving both physiology of the tree and of the forest, must be developed."

In the space of a brief article it is impossible to do justice to the many interesting features of the report of Messrs. Bailey and Spoehr. It merits careful study not only by foresters but by scientific men generally.

HENRY S. GRAVES

YALE FOREST SCHOOL

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### NEW FORMS OF DRY AND WET BULB THERMOMETERS

DRY and wet bulb thermometers are used mainly to obtain relative humidity. There are several well-known forms of hygrometers which by simple manipulation of index hands enable one to read on an adjacent chart the relative humidity and the dew-point; but in general, meteorological stations use a sling or whirled psychrometer, and have recourse to tables for the values mentioned above. For approximate values of the relative humidity at places where tables are not always at hand, there has been proposed lately a short-cut method.<sup>1</sup>

This method meets the approval of the Royal Meteorological Society but to us seems less satisfactory and convenient than a method which has been in use at Blue Hill Observatory for some years.

The Poulter formulas are:

$$(1) \text{ R. H.} = 100 - 350 d/t$$

$$(2) \text{ R. H.} = 100 - dd/2$$

<sup>1</sup> *Quart. Journ. Roy. Meteor. Soc.*, October, 1928, method of R. M. Poulter.

in which  $d$  is the difference between the dry and wet readings of the thermometers. For example, if the dry read  $69^\circ \text{ F.}$  and the wet  $59^\circ \text{ F.}$  the relative humidity would be 49 per cent. by (1) and 50 per cent. by (2). These values, however, are in error about 5 per cent. if we use the generally accepted formula

$$(3) \text{ e} = e^1 - .00367 \text{ P } (t - t_1) \left(1 + \frac{Z - 32}{1571}\right)$$

in which the units are inches of mercury and Fahrenheit degrees. For the values given above ( $69^\circ \text{ F.}$  and  $59^\circ \text{ F.}$ ) this reduces to .387 inch divided by .707 inch (the respective wet and dry saturation pressures, or 55 per cent. relative humidity).

The process becomes much simplified if units of force for pressure and kilograds for temperature are employed. Thus for a megabar pressure, *i.e.*, megadyne per square centimeter, or the new standard atmosphere, the relation is

$$(4) \text{ p}_s = \text{p}_a - .20 d$$



in which  $p_s$  is the vapor pressure at saturation,  $p_a$  at evaporation and  $d$  the difference between dry and wet temperatures. These values can be read directly from the new type instruments. Example: M 76 dry, and M 56 wet. The value of the right-hand part of (4) is  $17.4 - 4.0$  (kilodynes per square centimeter). We have then directly the ratio of the vapor pressures,  $13.4/24.5$ , or 55 per cent., as the relative humidity.

On these new instruments one can read also the saturation *weights* as well as pressures, hence it is an easy matter to compute the absolute humidity; thus, for above values,

$$18.1 \times .55 = 9.6 \text{ grams per cubic meter of space.}$$

We now have values conforming to the C. G. S. system of units. In order to bring the mb (millibar of meteorologists) into step with the bar of physicists and chemists, in use long before meteorologists woke up to the need of scientific units, we simply read kilobar for millibar. The bar like the dyne is a basic unit, the force which would give an acceleration of one centimeter per second per second to one gram.

It is interesting to note the increasing use of the prefix *kilo*, for we now meet in common usage not only kilogram, kilometer, kilocycle and kilowatt but also kilovolt, kilojoule ( $10^{10}$  ergs), kilocal and kilobar.

ALEXANDER MCADIE

BLUE HILL OBSERVATORY

## SPECIAL ARTICLES

### IS OSSIFICATION INFLUENCED SOLELY BY ULTRA-VIOLET LIGHT?

OWING to the increasing interest in the physiological properties of ultra-violet light in the prevention and cure of rickets, legweakness in poultry and nutritional paralysis in swine, the following data, obtained in 1926, may be of interest to workers in the field of light therapy.

At that time we were conducting routine determinations of the ossifying potency of different sources of light, by means of the bone-ash method.<sup>1</sup> The question arose relative to the effect of diffused laboratory light and ordinary electric illumination on the ossification process. This question was raised because of rather constant variations in the bone ash of rats which were reared in different parts of the laboratory. Rats whose cages were continuously shaded or darkened invariably manifested a lower rate of calcification as compared with their own litter mates on the same ration, but whose cages were less shaded during the ordinary working hours.

The animal laboratory is situated in a half-story attic on the third floor, and the building is almost entirely surrounded by tall trees. As a result, the windows, which are small, are partly shaded. Practically no direct sunlight can reach the windows and little of this can penetrate into the laboratory, and the windows are usually closed during the cooler months. Consequently, it is necessary to work by electric light most of the year. These lights consisted of 75-watt Mazda bulbs hung at a distance of about twelve feet above the floor. The cages, which consisted of wood frame and wire mesh, were of the apartment type, consequently, most of the animals were shaded most of the time.

To determine, if possible, the effect of laboratory light on the calcification rate, litter mates twenty-one days of age and weighing approximately forty grams

were divided into four experimental groups, all of which received the Wisconsin rachitogenic ration.<sup>2</sup> Group I was placed in a cylindrical wire-mesh cage covered with loosely woven black muslin cloth in which an opening was made through which was introduced a 100-watt Mazda bulb which was allowed to burn eight hours per day. Group II was placed in a similar cage which was covered completely with the black muslin cloth. Group III was placed in a similar cage without cover of any kind and exposed to the ordinary laboratory light. Group IV was treated the same as Group II except that the covering material consisted of cardboard arranged in such a manner that light was excluded completely but with facilities for air circulation. The following results were obtained when the femur bones were dried, extracted and ashed at the end of a twenty-one-day feeding period, the percentage of ash being calculated on the dry, fat-free basis.

Group	Treatment	Bone ash per cent.
I	Mazda bulb 8 hours per day.....	31.82
II	Dark cage—muslin cloth.....	22.44
III	Laboratory light.....	25.33
IV	Dark cage—cardboard cover.....	16.65

An additional experiment was conducted in which the feeding period was lengthened to thirty-five days, the results of which were as follows:

Group	Treatment	Bone ash per cent.
V	Mazda bulb 24 hours per day.....	50.59
VI	Dark cage.....	18.46
VII	Laboratory light.....	26.48
VIII	Two drops cod-liver oil daily.....	38.95

<sup>1</sup> R. A. Dutcher, M. Creighton and H. Rothrock, *J. Biol. Chem.*, 1925, 66: 401.

<sup>2</sup> H. Steenbock and A. Black, *J. Biol. Chem.*, 1925, 64: 263.

While we have had no facilities for determining the amount of ultra-violet light to which these animals were exposed, we have every reason to believe that it must have been negligible, since most authorities are agreed that the production of ultra-violet light by the ordinary filament is small and that this is largely if not completely absorbed by the glass bulb. While the possibility is not excluded that the variations in bone deposition are due to ultra-violet light, we can not escape the conclusion that the longer wave-lengths also possess ossifying power.

These observations are in accord with our observations (R.A.D.) on poultry, in which we have noted definite superiority of birds reared on a leg-weakness-producing diet and exposed to sunshine, as compared with birds subsisting on the same ration but irradiated with ultra-violet light from the quartz mercury vapor lamp.

R. ADAMS DUTCHER

H. E. HONEYWELL

PENNSYLVANIA STATE COLLEGE

#### A COMPARISON OF THE COPPER CONTENT OF OKLAHOMA WHEAT WITH THOSE OF OTHER STATES

As part of a study on the copper content of Oklahoma plants, we secured wheat samples from various states<sup>1</sup> and analyzed them for copper according to the tentative method published in the proceedings of the Association of Official Agricultural Chemists.<sup>2</sup> Ash and moisture determinations were run in the conventional manner.

It was thought that these figures might be of interest in indicating the relative abundance of copper in the different parts of the United States, such an assumption being based on the work of several scientists, most recent of which is the work of Elvehjem and Hart,<sup>3</sup> in which they indicate that the copper content of the soil is reflected in the plants grown thereon.

As might be expected, there are considerable differences in the various percentages, reaching in one case slightly over 100 per cent. On the other hand, the totals are small in any case and the percentages are not such as to show any great abundance or lack of copper in any section represented.

<sup>1</sup> We desire to thank the various experiment station workers who so generously furnished us with the samples for these analyses.

<sup>2</sup> *Journal of the Association of Official Agricultural Chemists*, xii: 35-36, 1929.

<sup>3</sup> C. A. Elvehjem and E. B. Hart, "The Copper Content of Feeding-stuffs," *J. Biol. Chem.*, lxxii: 473-477, 1929.

TABLE I  
ANALYSIS OF OKLAHOMA WHEATS  
(Copper expressed in milligrams per kilogram of material)

Variety	Per cent. Moisture	Per cent. Ash	Cu. in Fresh Wt.	Cu. in Ash Fresh Wt.
Kanred .....	9.3	2.07	6.0	289
Blackhull .....	10.5	2.00	6.3	315
Fulcaster .....	9.1	2.21	7.0	313
Unnamed .....	9.1	1.64	5.1	314
Turkey .....	7.8	1.99	6.8	343
Average .....	9.2	1.98	6.2	315

TABLE II  
ANALYSIS OF WHEATS FROM VARIOUS REGIONS OF THE UNITED STATES  
(Copper expressed in milligrams per kilogram of material)

State	Variety	Per cent. Moisture	Per cent. Ash	Cu. in Fresh Wt.	Cu. in Ash Fresh Wt.
Rhode Island	Golden Chaff	8.8	1.52	5.3	348
Virginia	V. P. I. 112 wheat	8.8	1.68	6.8	403
Texas	Denton	9.6	1.49	7.8	524
Indiana	Fultz	10.0	1.94	6.6	339
Oregon	Unnamed	8.2	1.50	4.2	281
Arizona	Boart	10.3	1.45	6.0	414
New Hampshire	Ohio Trumbull	6.8	1.73	4.4	254
Wyoming	Unnamed	6.6	1.73	4.5	261
Colorado	Kanred	7.9	1.61	5.8	362
Ohio	Average of six	9.2	1.84	6.1	331
Missouri	Michigan Wonder	8.6	1.84	6.2	339
California	C. I. 1442	6.3	1.75	8.7	497
Oklahoma	Average of five	9.2	1.98	6.2	315
Average of states .....		8.8	1.78	6.0	345

The only noticeable trend in the percentages is that the northern samples are, as a rule, the lowest. There are, however, not enough analyses reported here to make this fact assume any great importance. Finally, there seems to be no relation between the ash content and the copper content, which fact is perhaps surprising in view of the probable adsorption of copper along with other mineral elements.

JAMES E. WEBSTER

FRANK JANSMA

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE



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## SCIENCE NEWS

Science Service, Washington, D. C.

## THE EARTH AS A POWER HOUSE

THE earth itself is a huge electric dynamo generating enough current to supply light, heat and other electrical needs to the ten largest cities in the United States for at least one million years. Recent researches on thermal reactions inside the earth, conducted by Dr. Ross Gunn, of the Naval Research Laboratories, and inventor of a short-wave oscillator and airplane altimeter that have been taken up by the radio and aircraft industries, indicate that the earth is the greatest known electrical wonder in the universe.

Dr. Gunn has published a theoretical treatise on his studies in *The Physical Review*. The intricate theoretical problem of the earth's electrical condition showed that the currents generated inside the earth amount to more than 200,000,000 amperes. Dr. Gunn is careful to emphasize that this tremendous source of energy is unavailable for use by man. Like atomic energy, it will be kept in nature's storehouse for the use of the generations of perhaps a million years in the future.

According to Dr. Gunn, the tremendous electrical currents that are produced inside the earth arise from the motions of the tiny electrical charges known as electrons. The motions are caused by the very high temperatures existing well inside the earth's crust.

Due to a peculiar and complicated type of interaction the electrons are caused to drift around the earth's axis of rotation. This drift of electrons constitutes an electric current which is so large that if it were sent through the huge cables supporting Brooklyn Bridge it would melt them in less than a thousandth of a second.

The presence of the currents that flow in the hot interior of the earth may be detected by any one who cares to observe the action of a magnetic compass on the surface of the earth, for it is precisely these deep-seated electric currents that orient the compass needle in a north-south direction. He adds that it has been known for thousands of years that the earth behaved like a giant magnet, but the mechanism by which this magnetism was produced was not understood.

The study pursued by Dr. Gunn sheds much light on the manner in which the earth was originally formed. His work and known facts relating to the earth's magnetic field indicate that the earth was part of the sun or some other liquid star millions of years ago. When the earth was thrown off the sun, it came off in such a manner that the hemisphere now embraced by the continents was made up of relatively cool surface material having a mean temperature of perhaps 50,000 degrees while the hemisphere embraced by the Pacific Ocean came from deeper and much hotter layers.

This unsymmetrical temperature distribution of the earth's interior is said to account for the volcanic activity and earthquakes in the countries in and adjacent to the Pacific Ocean.

## FORECASTS OF ENGLISH WEATHER

STORMS which hampered the early days of the Boy Scouts' jamboree in England are but a forecast of a return to normal rainfall for the second half of 1929, after an exceedingly dry six months, according to predictions of Dr. Dinsmore Alter, professor of astronomy at the University of Kansas.

A test prediction by Dr. Alter, published in the *U. S. Monthly Weather Review* for June, 1927, forecast the dry season through which the British Isles have just passed. If the observed rainfall follows the prediction for the next six months as closely as it has in the past several years, England may look for approximately normal rainfall during the rest of the year. After a damp spring in 1930, the prediction indicates that England may experience two years of sub-normal rainfall.

Dr. Alter has published a dozen papers on periodicity of rainfall, basing his studies on records from many sections of the world. The British Isles and the Pacific Coast of North America, with their purely marine types of weather, and the purely continental types as found in the Punjab of India and in Siberia gave the most consistent results when mathematical formulae were applied.

The British Isles predictions, for example, were based on a study of data from six different places, covering the years from 1834 to 1924. From these data, a periodogram was computed with a dozen or more peaks, the four principal of which were applied in producing the chart published in the United States two years ago, and making test predictions up to 1940.

Actual reports received since the test prediction was published have been charted, and found to have a high correlation. The predicted excess of rainfall by 12 per cent., in the spring of 1926, was found actually to be 18 per cent. excess of normal. The predicted excess of 3 per cent. in the fall of 1923 became an actual 4 per cent. deficiency, but the predicted excess rainfall for the latter part of 1927 and all of 1928 was even exceeded by the actual figures. Reports received by Dr. Alter for the first three months of 1929 showed even less rainfall than the 22 per cent. he had predicted. The prediction is "practically normal" for the second half of this year.

Dr. Alter leaves for Europe the latter part of August to spend a year under a fellowship granted by the Guggenheim Foundation. He expects to spend the greater part of his time in England and Scotland, examining rainfall records, many of which are only in manuscript form, in a hope to discover further data that will make his predictions more accurate.

He disclaims all hope of being able to predict long in advance the weather probabilities for any particular day, but he does believe that there are possibilities in predicting in larger units the possible weather, especially as to rainfall. Such predictions, if reasonably accurate, he believes, would be of great benefit to agriculture.



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### COOPERATION OF THE UNITED STATES AND MEXICO IN FIGHTING INSECT PESTS

"INTIMATE collaboration between the United States and Mexico on plant quarantine and pest control is indispensable, we are convinced," said Mario J. Hoyo, official representative of the Mexican Government and chief of the Plant Protection Service of that country, at the tenth annual meeting of the Western Plant Quarantine Board which was held recently in Salt Lake City.

"A better understanding of mutual quarantine problems would facilitate beneficial interchange of agricultural products with ample protection to the agricultural interests of both Mexico and the United States," he said. "In creating our zone of agricultural defense against the further spread of the Mexican fruit-fly, the pink-boll weevil, the avocado weevil, the potato weevil and other pests in our own country on the northwest Mexican coast, we are not only defending our interests in Sonora, Sinaloa and Nayarit, but of your western states as well."

Mr. Hoyo described the fumigation plant which the Mexican Department of Agriculture has built in Guadalajara in the State of Jalisco, the gateway to the Mexican west coast, which for some time was the biggest in the world. The fumigation chamber is a steel vacuum cylinder about 165 feet long and 17 feet in diameter, and divided into two sections. The first section is 45 feet long and in it one railroad box car may be fumigated. The other vacuum chamber has a capacity of 25,000 cubic feet and can take care of two box cars at a time, but can be enlarged to accommodate four. The cars are run in on tracks laid inside and firmly fixed to the sides.

Liquid hydrocyanic acid gas is used for fumigation. Two hours of high-vacuum fumigation are used for box cars loaded with cotton, and one hour for other vegetable products. There is a special inspection service of all railroad cars which come from the Mexican interior and are bound for the west coast, and it is absolutely forbidden to take fruits or vegetables or other prohibited products under quarantine on such trains.

Mr. Hoyo pointed out that Mexico is but a prolongation of western United States, and that the Rocky Mountains which divide the United States into east and west run all the way to the Rio Grande Valley, leaving but an insignificant portion of Mexico out of the western realm. This means that the United States and Mexico are a geographical unit and that the agriculture of the two countries is of necessity intimately linked.

"The newest and most serious agricultural menace is one which your country and ours must face together," said Mr. Hoyo, referring to the Mediterranean fruit-fly which has recently made its appearance in Florida and other eastern American states. "Mexico is as much concerned as western United States in keeping this pest out, and our fruit culture is in the same dangerous position as yours. We are making every effort to protect our frontiers and are enforcing the quarantine against its introduction with all the means at our disposal.

"Our fight would be a hopeless one if the insect should become an element of the California citrus groves. It

would necessitate strict vigilance on our part along the Mexican border against bootlegged fruits, and would sap our available funds for pest control and quarantine work in general, with the result that both sides would suffer.

"The Mexican fruit-fly is an international problem, and our hopes are that the entire plant protection and quarantine activities of the North American continent will be organized against this most dangerous pest of our fruit culture. The Mexican Government is prepared to collaborate in every possible manner."

### CANCER CULTURE CARRIED BY THE GRAF ZEPPELIN

THE *Graf Zeppelin* on its speedy trip from Germany brought to the Cancer Research Laboratory of the University of Pennsylvania cultures of cancer cells of a special rat sarcoma type that would not have survived the long steamer voyage across the Atlantic.

"The cultures must be transplanted every few days and the *Graf Zeppelin* offered a quick method of transportation so that they may be transplanted on their arrival here," explained Dr. Ellice McDonald, director of the Cancer Research Laboratory of the University of Pennsylvania's Graduate School of Medicine, to whom the valuable cancer cultures were consigned. "It is almost impossible to carry the necessary laboratory apparatus to make these transplantations on board a steamship."

The growing cancer cells came from the Kaiser Wilhelm Institut für Biologie in Berlin through arrangements made by Dr. Raymond Parker, of Dr. McDonald's staff, and Professor William Seifriz, of the University of Pennsylvania. Dr. Parker has been studying this year at the institute with Professor Albert Fischer.

Although not the same kind of cancer that affects human beings, the rat strain when safely established in its new American home will prove useful in the laboratory's study of mitosis or cell division. It is also expected that the cancer cultures will throw new light upon the possibility of the modification of the rate of growth or cell division by various chemicals, and it is possible that such experiments may prove to be the starting point of new knowledge of the human disease. Human cancer like the cancers of lower animals, such as the rat, is primarily a disease of cell division and the proposed studies upon the *Graf Zeppelin* culture are therefore fundamental.

### AIRPLANE SERVICE ACROSS THE GRAND CANYON

THE north and south rims of the Grand Canyon of the Colorado are now spanned by a scheduled passenger transportation line that for the first time in history betters the two-day time of the mule-back trip down into and across the canyon which heretofore has been the only regular means of crossing the canyon directly.

Airplanes make the trip in thirty minutes' flying time. Propelled by three 550 horsepower motors, the fifteen-passenger airplanes are using a natural field in the Kaibab forest, 8,000 feet in altitude, claimed to be the highest regularly used airport in the world. It is often



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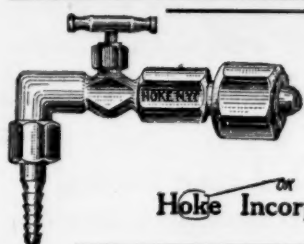
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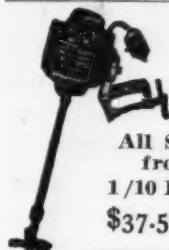
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necessary to scare herds of deer off the field before the airplanes can be landed.

From the south rim, 7,000 feet in altitude, the airplane rises another 3,000 to 4,000 feet in order that the great chasm, over a mile deep, can be traversed safely. An emergency landing field on one of the great terraces in the canyon's depths has been cleared and a test landing made.

In addition to serving as a quick means of transportation for those desiring to travel directly southward or northward between Salt Lake City and other areas north of the canyon and southern Arizona, previously a two-day round about rail trip, one day or one afternoon excursions from one rim to the other and return have been added to side-trips possible from either rim of the canyon.

Automobilists can pass from rim to rim over a circuitous route and merely passable roads *via* the new Lee's Ferry Bridge, but this requires at least two days.

Scenic airplane trips over the Grand Canyon from the south rim have been available for over a year but the first landing of the passenger airplanes on the north rim was made this summer. The regularly scheduled air line across the canyon has just been placed in operation. The first airplane flight over the canyon was made by an army officer, Lieutenant Alexander Pearson, on June 10, 1921.

Traversing the canyon by airplane costs approximately two thirds as much as crossing on mule-back.

### ITEMS

THE number of claims which have been filed with the Ohio Industrial Commission for injuries received while using frozen carbon dioxide, or "dry ice," for industrial purposes, has caused the U. S. Government to issue a warning to workers handling this product. The "dry ice" has recently come into extensive use for commercial purposes, especially in ice-cream and dairy plants. Its temperature is about 110 degrees below zero or 140 degrees below the temperature of ordinary ice. Although it looks harmless enough it can do considerable damage to the person who handles it with bare hands. Numbness and pain, not only in the fingers but also in the hands and arms, are the first symptoms, and in some cases a form of neuritis is produced.

THE U. S. Bureau of Mines, in cooperation with the bridge and tunnel commissions of New Jersey and New York, has recently conducted an experiment to discover whether persons exposed for long periods of time to the exhaust fumes in the Holland Vehicular Tunnel would become ill. Six men volunteered to breathe the fumes for from four to seven hours each day over a period of 68 days. The gas mixture used in the experiment contained 2, 3 and 4 parts of carbon monoxide to 10,000 parts of air. Some of the men had frontal headaches after breathing the mildest mixture for 3½ hours and after an exposure of only 1½ hours to the strongest mixtures. After four hours of exposure to the 4-part mixture the blood had absorbed the gas to an extent of 30 per cent.

No serious effects were noted in the short time that it would take to drive through the tunnel.

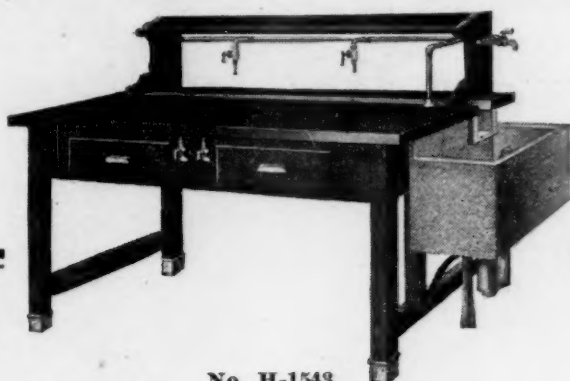
INHALING carbon dioxide gas temporarily restored the sanity of mentally deranged patients at the University of California Medical School. The experiments were conducted at the request of Dr. A. S. Loevenhart and Dr. Ralph M. Waters, of the University of Wisconsin, the former of whom has since died. The tests were made by Dr. Chauncey D. Leake and Dr. Mary E. Botsford, of the University of California, with the help of Dr. Arthur E. Guedel, of Beverly Hills, and some six other physicians. Eight trials of the treatment were made on five cases of the type of insanity known as dementia praecox catatonica. In all but one trial there was a fleeting return of intelligence which enabled the patients to answer questions rationally, or to exhibit recognition of their surroundings. These periods of rationality lasted from ten to fifteen minutes.

THE annual death rate on the Gold Coast has been reduced from 100 per thousand of non-official residents, which was the rate in 1897, to 9 per thousand. A report received by the American Medical Association credits this improvement in health conditions to the opening up of the country by railways, to the installation of ice and cold storage plants, and to the efforts of scientists in combating the diseases prevalent in that region.

RUSSIA is no longer a customer for German potassium salts, source of fertilizers and other widely used commercial chemicals. In 1926 the Soviet Government started investigations to see if Russia did not have any deposits of her own of these valuable materials, with the result that near Solikamsk in the Ural Mountains potassium beds were found that the Soviets claim to be among the largest in the world. A mine has been constructed, workmen's quarters erected and mining operations are said to have begun this summer. Some 5,000 men are employed to handle the production which, it is estimated, will reach around 1,300,000 tons per year.

COMPUTATIONS of triangulation observations of the Peak Garmo have been completed by Richard Finsterwalder, a member of the Soviet-German expedition to Pamir, showing that Peak Garmo has a greater altitude than any other mountain in the Union of Socialist Soviet Republics. Its height is computed as being 7,495 meters, or about 24,583 feet. No mountain on this side of the world exceeds Peak Garmo in height. The tallest in North America, Mount McKinley, is only 20,300 feet in height, while South America's loftiest peak reaches but 23,080 feet. Peak Garmo is also taller than any of the peaks in the Alps. In fact, the only mountains which are known to be taller are some of the peaks in the Himalayas and other of the tallest Asiatic mountains. Peak Garmo lies among the wild and inaccessible summits of the Pamir Mountains. Its heights have probably never been reached by any human being.





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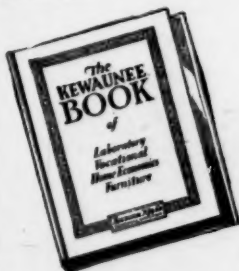
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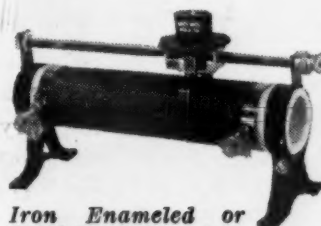


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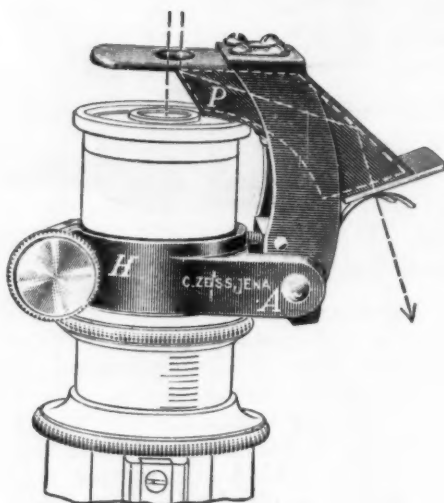
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